

A SATURN LAUNCHED

X-RAY ASTRONOMY EXPERIMENT

FINAL PROGRAM REPORT

VOLUME I

S-027

SUBMITTED IN ACCORDANCE WITH

SUBCONTRACT NO. 1

UNDER PRIME NASA CONTRACT NAS 8-21015

UNIVERSITY OF WISCONSIN MADISON, WISCONSIN

ORIGINAL

March 11, 1971

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SCI SYSTEMS, INC.

HUNTSVILLE DIVISION

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PREPARED BY

SCI ELECTRONICS, INC. 8620 SOUTH MEMORIAL PARKWAY HUNTSVILLE, ALABAMA

FOREWORD

The final program report for the Saturn Launched X-Ray Astronomy Experiment is comprised of two (2) volumes. The first volume describes the original X-Ray Experiment, designated S-027, with a sensitivity range from 2 kev to 10 kev. The second volume describes the soft X-Ray version, designated S-150, with a sensitivity range from 200 ev to 10 kev.

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PHASE ONE

FINAL REPORT

FOR

S-027

X-RAY ASTRONOMY

ORIGINAL APPROVALS

Special Projects Section

<u>8/20/73</u> Date

T.H. Freisen, Manager

Special Projects Section

8-20-13 Date

1.0 SUMMARY

The S-027 X-Ray Astronomy Experiment originally proposed in early 1966, was developed to detect x-rays in the 2 kev to 10 kev range. Both a prototype unit and flight unit were constructed with the prototype unit also serving as the engineering model, the qualification test unit, and after refurbishment, as the back-up flight unit. Two Ground Support Equipment consoles were built to verify the experiment operation. A photograph of one experiment package with its Ground Support Equipment is shown in Figure 1.0-1.

The S-027 experiment was scheduled for launch in 1968/69 and although both units were completed and tested to the extent that either would be ready for the scheduled launch, delays in the space program resulted in a launch date slip of several years.

When the 1968/69 launch delay became official, provisions were made for storage of the two experiment packages at SCI Electronics in Huntsville, Alabama until a new launch date could be established. At this time the new launch date was tentatively scheduled to be in 1971/72.



X-RAY ASTRONOMY EXPERIMENT WITH GROUND SUPPORT EQUIPMENT, BOTTOM VIEW

2.0 INTRODUCTION

The S-027 X-Ray Astronomy Experiment was developed to explore the sky for x-ray energy sources in the range from 2 kev to 10 kev. The experiment was scheduled to be flown in 1968 as part of the Apollo Program Missions as a secondary exploration in that it was located in the Saturn Instrument Unit and flew completely passive until the primary mission - that of orbiting the Apollo craft - was completed. After separation of the command Service Module from the Saturn Instrument Unit, the experiment was to be deployed from its storage position to its active position by command from the ground thru Instrument Unit Telemetry links. A drawing of the experiment in its deployed position is shown in figure 2.0-1. Figures 2.0-2 and 2.0-3 are pictures of the bottom and top of the experiment respectively.

To achieve its goal of exploring the sky for x-ray sources in the 2 kev to 10 kev range, the experiment used gas filled Argon Xenon proportional counters with 5 mil thick beryllium windows as the sensors. Ten of the counters were included. Each counter was restricted in its viewing area by mechanical collimators located in front of the windows. The collimators were oriented as shown in figure 2.0-1 to collimate at 90°, 45° and -45° angles. This collimation effect allowed more accurate determination to be made from the processed data as to the location in the sky of the x-ray source observed.

The signals detected by the counter were amplified by charge amplifiers, quantized into one of five energy levels by pulse height analyzers, and then processed in a data processor for transmission by Instrument Unit Telemetry to the earth.

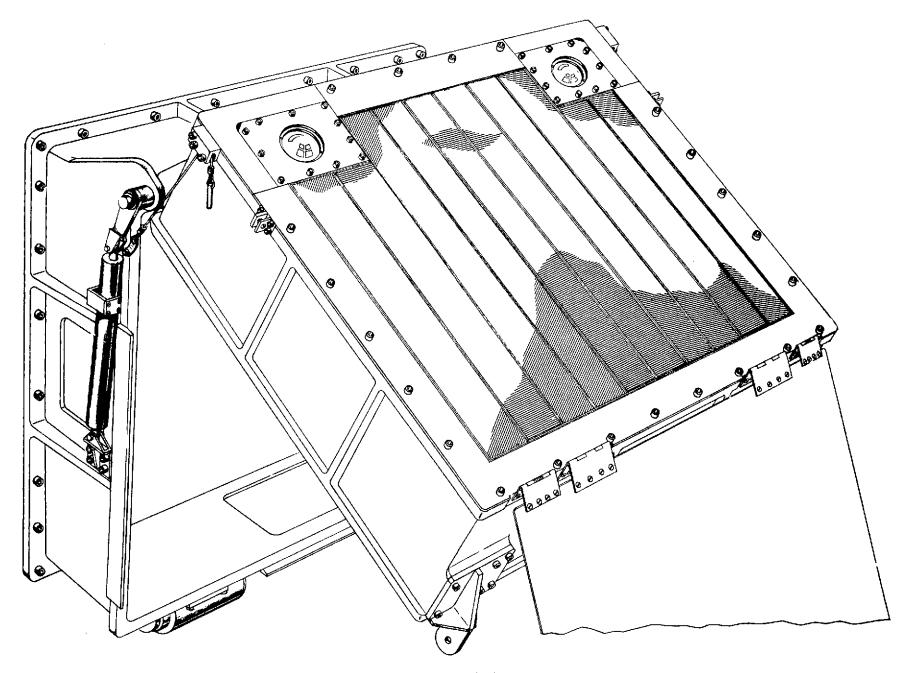


FIGURE 2.0-1 S-027 X-RAY ASTRONOMY EXPERIMENT

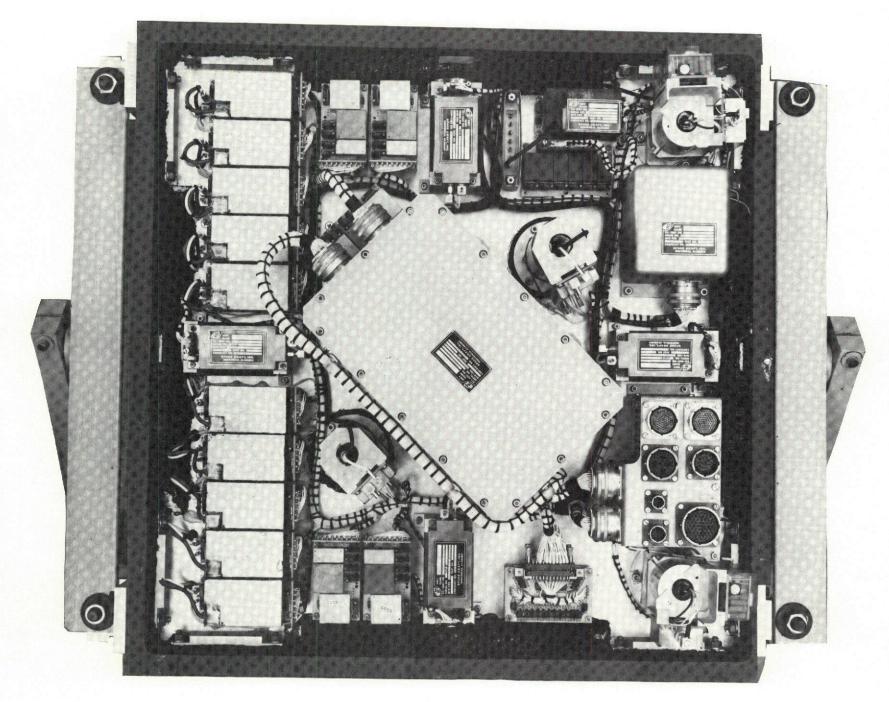


FIGURE 2.0-2
X-RAY ASTRONOMY EXPERIMENT,
BOTTOM VIEW

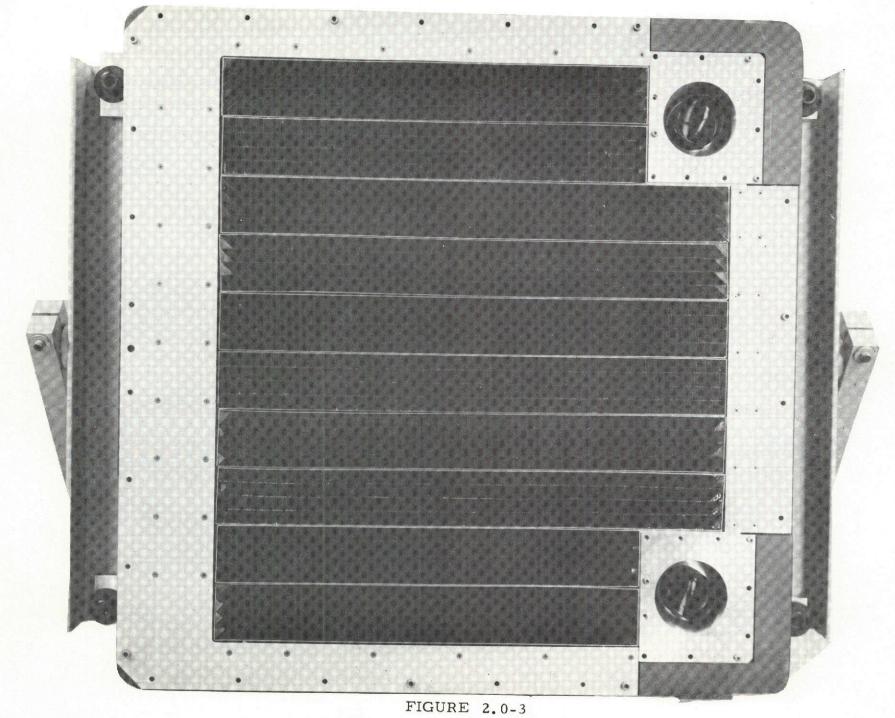


FIGURE 2.0-3
X-RAY ASTRONOMY EXPERIMENT,
TOP VIEW

In order to record only the x-rays in the desired energy range, a fluerguard phototube assembly was used in conjunction with a plastic scintillator
to detect higher energy radiation which was used to provide veto information
to the data processor to inhibit all x-ray counts which occurred during the
period of higher energy activity.

A star sensor system was included to more accurately determine the area of space the sensor was viewing.

The experiment contained its own self-calibration feature and was to be subjected to calibration checks each thirty minutes of flight by command.

A block diagram of the S-027 experiment is shown in figure 2.0-4.

A detailed description of each subsystem contained in the experiment is given in Section 3.0 of this report.

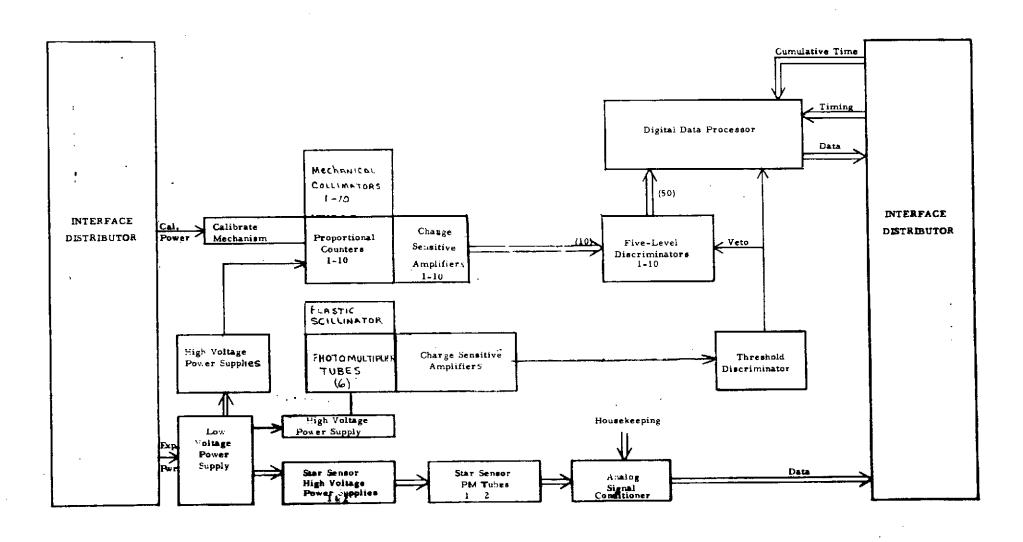


FIGURE 2.0-4 S-027 X-RAY ASTRONOMY EXPERIMENT BLOCK DIAGRAM

3.0 EXPERIMENT DISCUSSION

As shown on the block diagram in figure 2.0-4, the experiment consists of several subsystems which may be isolated for discussion.

These are the signal detection system including the mechanical collimators and signal conditioning, the Fluorguard veto system, the Data Processor, the Star Sensors, and the Calibration mechanism. Each of these is discussed in the following sections.

3.1 SIGNAL DETECTION SYSTEM

A block diagram of the signal detection system is shown in figure 3.1-1. The signal detection system consists of the ten mechanical collimators, the ten proportional counters, the high voltage supplies, the charge amplifiers and the 5 level discriminators.

The mechanical collimators are used to restrict the viewing area of the proportional counters to a narrow area for each of the ten counters. This allows the experimenter to more accurately determine from the processed data the location in the mapped area that the x-ray energy originated.

Each of the ten proportional counters is a closed cavity filled with a mixture of Argon-Xenon counting gas with an anode wire extending the length of the cavity. The counter window is made of 5 mil beryllium. During operation the anode wire is operated at a potential of several thousand volts. As x-rays strike the counters the gas is ionized to an extent determined by the x-ray energy detected. The gain of the counter is a function of the counter gas and high voltage. A signal is generated on the anode wire and is capacitively coupled from the counter to the charge amplifier for signal amplification. After amplification by the variable gain charge amplifiers the signals are quantized into one of five levels by a pulse height analyzer

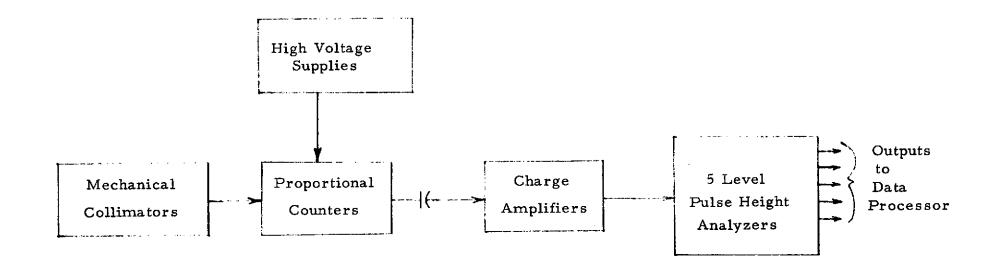


FIGURE 3.1-1

BLOCK DIAGRAM OF SIGNAL DETECTION SYSTEM S-027 X-RAY ASTRONOMY EXPERIMENT

circuit. Pulses contained in each of the five levels are of a known x-ray energy range since the threshold levels in the pulse height analyzer are adjusted to place certain energy ranges in a particular group.

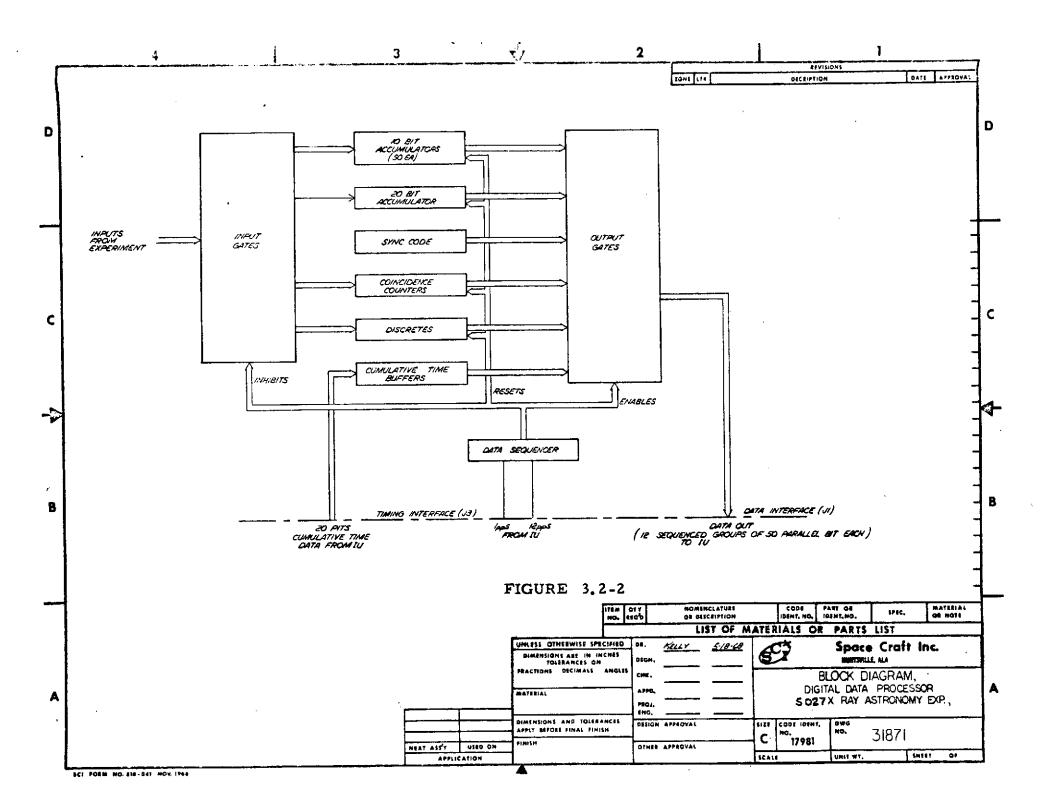
3.2 DIGITAL DATA PROCESSOR

The digital data processor utilizes high density integrated circuit, welded module packaging concepts. A photograph of the processor is shown in figure 3.2-1 and a block diagram is shown in figure 3.2-2. The majority of the system is involved with the primary detector's level discriminators. Capabilities exist to accept 50 lines of pulse data into the unit providing 10 bit accumulation (1023 counts) for each input. Sequencing of the data outputs is derived from timing inputs from the IU. Twelve separate data sequences are generated from the 12 pps timing input from the IU. Each sequence enables five accumulators of 10 bits each to the output circuitry. The 1 pps timing signal from the IU synchronizes the system by ordering the proper sequence of data groups. At the leading edge of the 12 pps pulse, the data accumulators to be interrogated are inhibited from further counting, and their outputs are presented to the digital data interface. The outputs remain available for sampling by the IU for a period of 700 microseconds at the end of which time the accumulators are reset and the input inhibit is lifted. At the next 12 pps pulse the second group of accumulators are connected to the output.

Synchronization words, cumulative time words, veto count accumulations, and some few coincidence counts are processed into the last two data groups.



FIGURE 3.2-1
DIGITAL DATA PROCESSOR
X-RAY ASTRONOMY



3.3 FLUOR GUARD PHOTOTUBE VETO SYSTEM

The S-027 utilized a Fluor Guard phototube veto system to detect energy levels higher than those to be analyzed by the experiment and to produce from these higher energies veto pulses to inhibit pulse counts in the data processor during the time of higher energy activity.

A block diagram of the veto system is shown in figure 3.3-1. The photo-tubes are operated from a -1000V dc supply. The signals detected by the tubes are amplified by charge amplifiers and sent to adjustable threshold discriminators which are ORed together at the output so that a signal detected by any one of the tubes will provide a veto pulse to the data processor.

A plastic scintillator sealed in a light tight cavity is used in conjunction with the phototube to detect the higher energy levels by producing a glow when struck by high energy radiation. Photographs of the Fluor Guard phototube system and the plastic scintillator are shown in figures 3.3-2, 3.3-3 and 3.3-4 respectively.

3.4 STAR SENSORS

In order to more accurately determine the viewing area monitored by the experiment, two star sensor assemblies were included in the experiment to provide location and orientation information in addition to that provided by the launch vehicle.

Each assembly consists of a lens, a field defining slit, and photomultiplier tube, a high voltage power supply, an electrometer, a buffer amplifier, and a high intensity light protection circuit. The two tubes project a field defining slit $0.1^{\circ} \times 10^{\circ}$ arranged to cross each other at 45° and each making an angle to the line of motion scribed by the sensor normal of 67.5° .

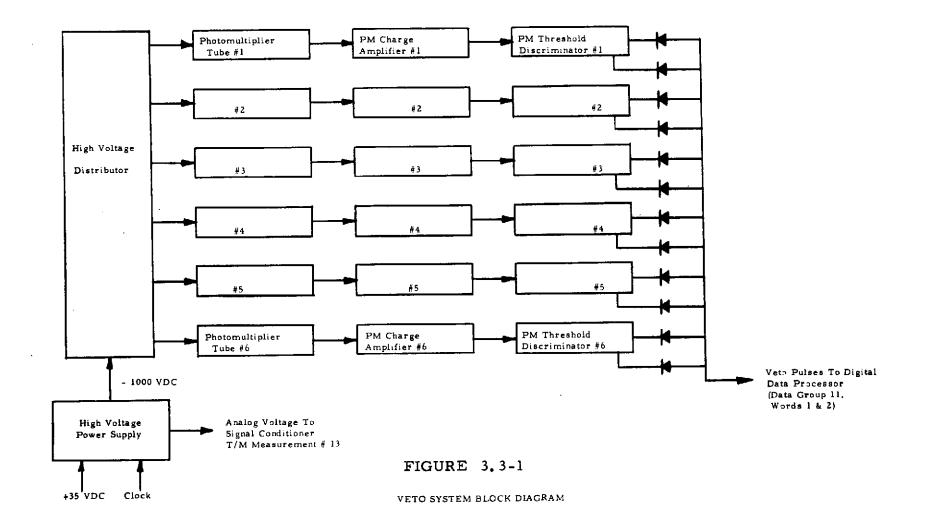




FIGURE 3.3-2

FLUOR GUARD PHOTOTUBE SYSTEM WITH CHARGE-SENSITIVE AMPLIFIER AND HIGH VOLTAGE POWER SUPPLY (X-RAY ASTRONOMY EXPERIMENT)

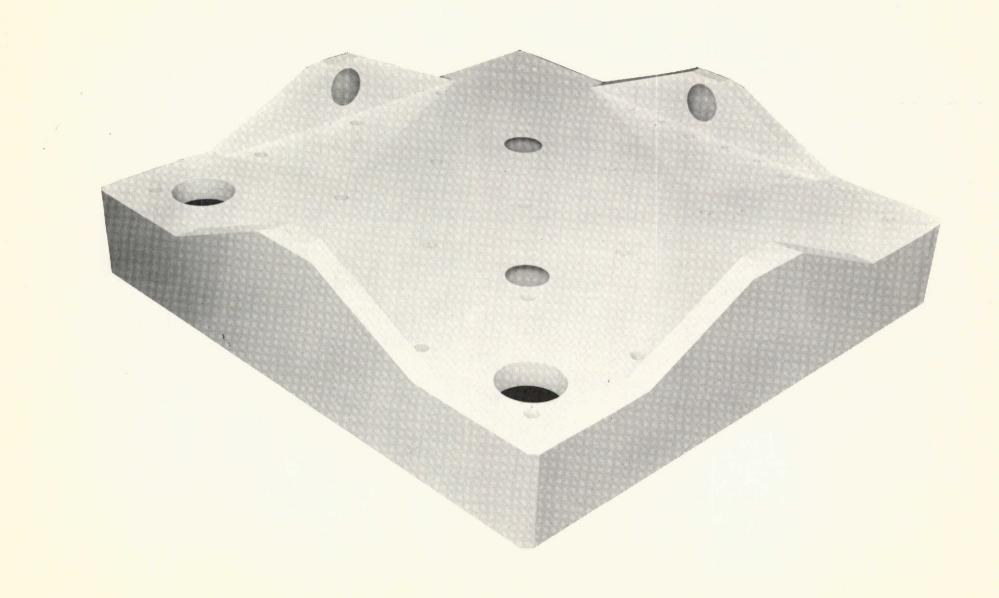


FIGURE 3.3-3

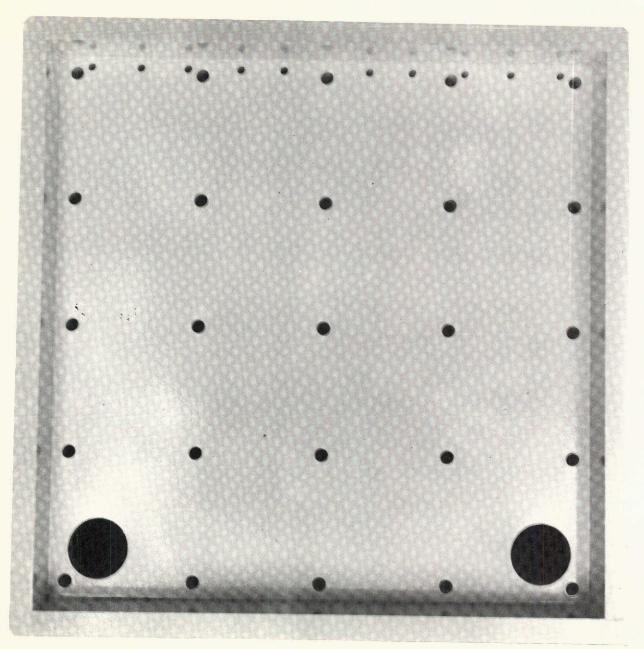


FIGURE 3.3-4
PLASTIC SCINTILLATOR, TOP VIEW
(X-RAY ASTRONOMY EXPERIMENT)

A block diagram of the star sensor electronics is shown in figure 3.4-1.

The high voltage supply produces accelerating potentials for the dynode assemblies in the phototube. Constant power is provided by the supply through the tubes resistive divider, unless the tube is operated into saturation from excessive light intensities incident in the star field.

The output from the phototube is conditioned and amplified by the electrometer and Buffer Amplifier contained in the amplifier assembly. A high intensity light protection circuit is included to reduce the voltage of the high voltage supply and thereby the gain of the phototube when intense light is in the field of view.

3.5 CALIBRATION MECHANISM

The S-027 utilizes a calibration rod with ten discrete Fe55 radioactive sources of ten microcuries each for verification of the experiment calibration accuracy. The rod is extended by a solenoid to expose the counters to the Fe55 sources for five seconds at thirty minute intervals during the experiment's active life. The in-flight calibration checks provided a high confidence level for data accuracy since every thirty minutes a block of reference data is recorded to allow checking the gain of the system.

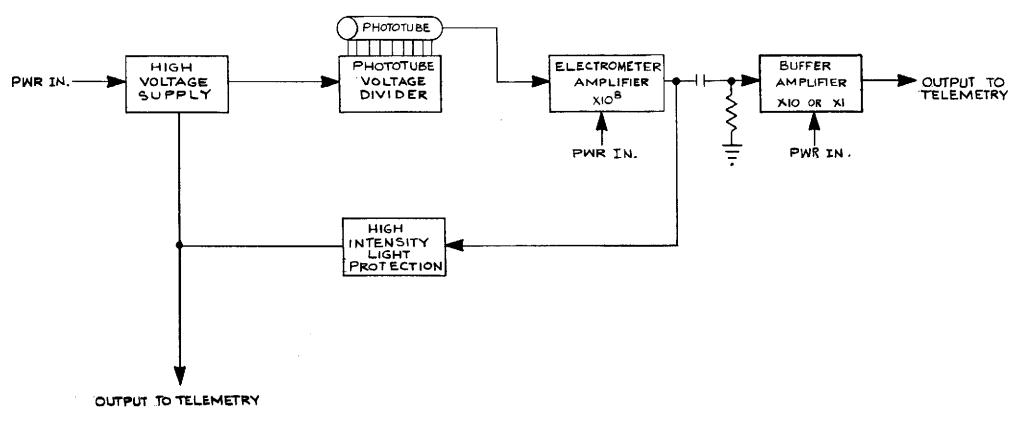


FIGURE 3.4-1
BLOCK DIAGRAM STAR SENSOR ELECTRONICS

4.0 SUBSYSTEM DESCRIPTION

Each subassembly contained in the S-027 is described in the following sections.

4.1 COUNTERS

There are ten counters contained in the experiment. Each counter is an Argon-Xenon gas filled cavity with an anode wire running the length of the cavity. Five sides of the cavity are made of aluminum and one side, the window side, is made of five mil thick beryllium. In operation a high voltage is applied to the wire and as x-ray energy strikes the gas an ionization occurs which is detected by a charge amplifier capacitively coupled to the anode wire. The magnitude of the signal is determined by the gas gain factor and the detected energy. The counters are shown mounted in the experiment in figure 4.1-1.

4.2 PROPORTIONAL COUNTER AND PHOTOMULTIPLIER CHARGE AMPLIFIERS

Schematics of the Charge Amplifiers are shown in figures 4.2-1 and 4.2-2. The same circuit is used for both the Proportional Counters and Photomultiplier Charge Amplifiers with the exception that several component values are changed between the two to produce the proper circuit responses.

A photograph of the proportional counter charge sensitive amplifier stacked with the proportional counter high voltage supply is shown in figure 4.1-4.

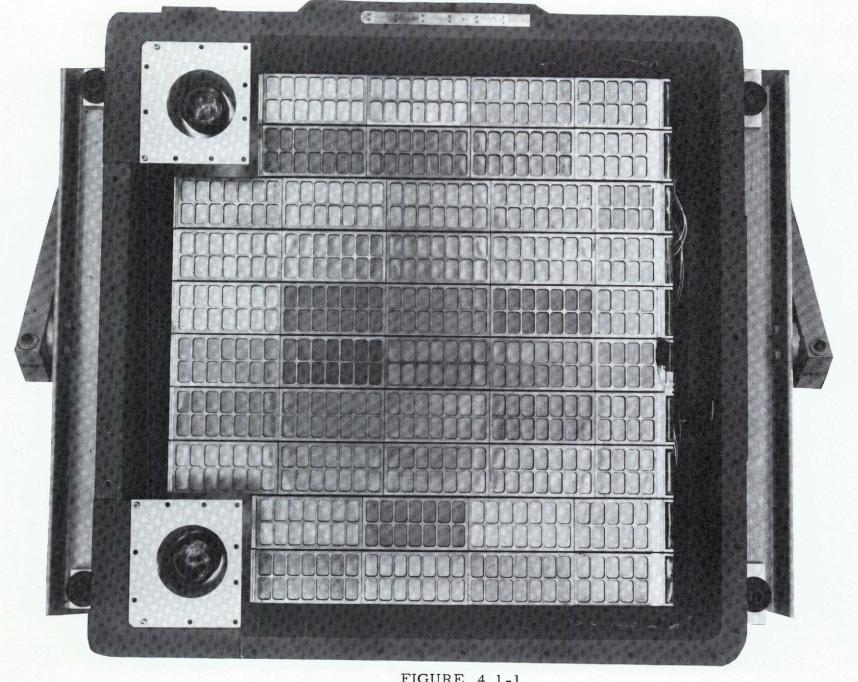
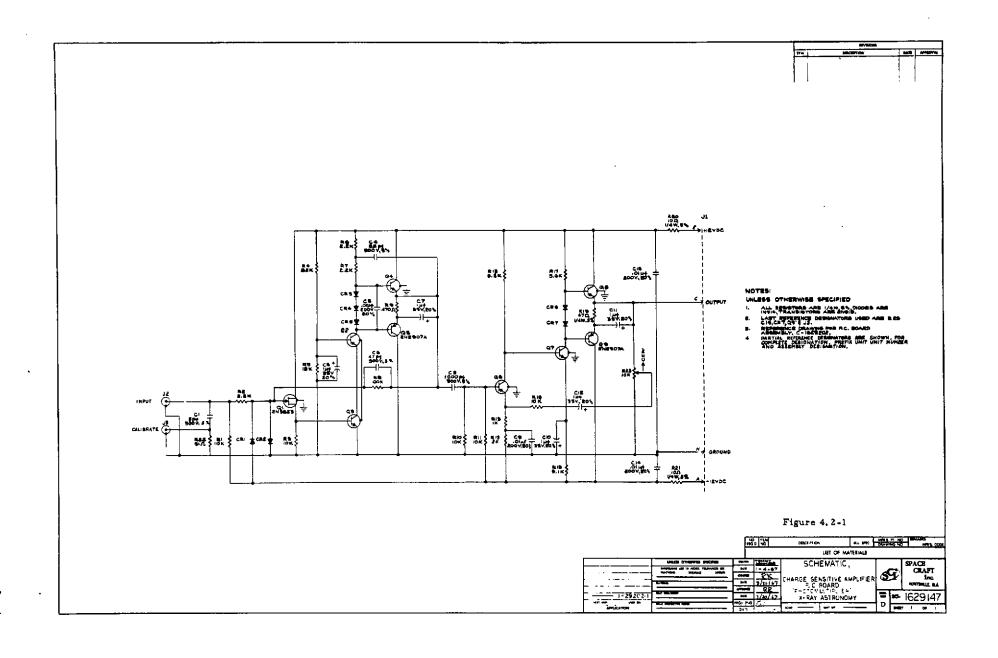
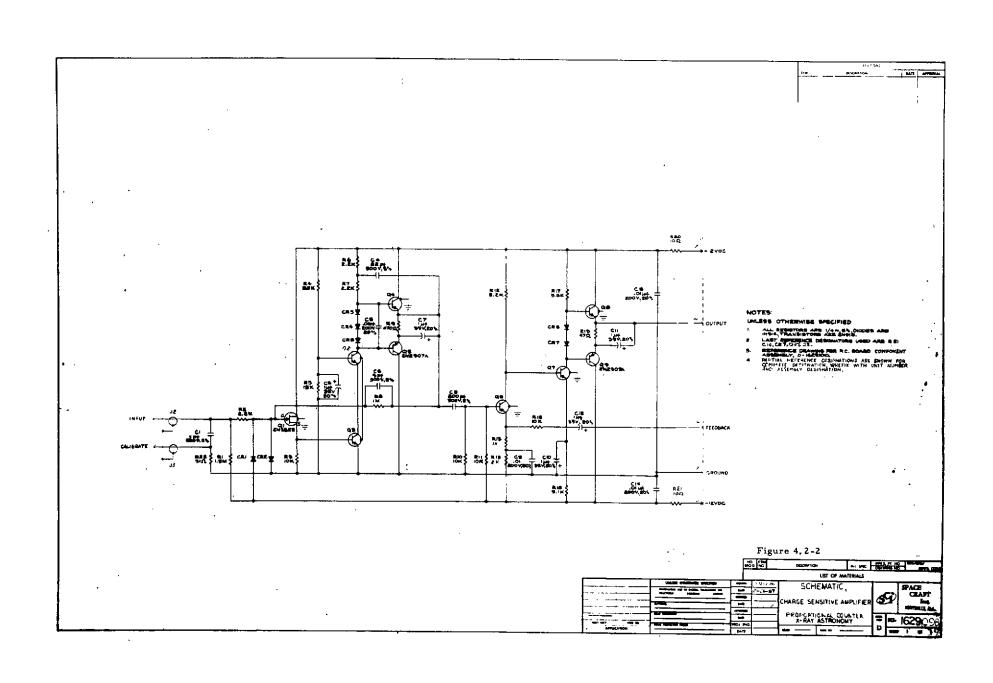


FIGURE 4.1-1
X-RAY ASTRONOMY EXPERIMENT,
TOP VIEW WITH COLLIMATORS
REMOVED





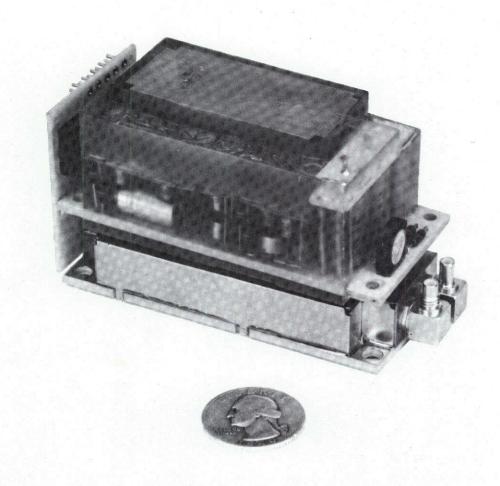


FIGURE 4.2-4

4.3 FIVE LEVEL DISCRIMINATOR

A block diagram of the Five Level Discriminator is shown in figure 4.3-1 and a schematic is shown in figure 4.3-2.

The input is obtained from the signal amplifier output. When an input is received, the signal triggers a one shot circuit which enables the analyzer and provides blanking for the duration of the one-shot pulse.

The circuit is designed so that an output is obtained from only the highest level that the input pulse is capable of triggering. Each level of the five level is adjustable over a selected range and each level is interconnected to inhibit the outputs of the lower levels. The fifth level is open-ended in that all pulses above its threshold level appear at the output.

A photograph of the Five-Level Discriminators in their stacked configuration is shown in figure 4.3-3.

4.4 HIGH VOLTAGE POWER SUPPLIES

A block diagram of the high voltage power supply configuration is shown in figure 4.4-1. Each supply operates from an unregulated input which is regulated by a series transistor internal to the high voltage supply. The regulated output is then stepped up in the converter module by a 1:25 ratio. The final output is obtained from a voltage multiplier circuit. The output is sampled and compared to a reference voltage in a comparison amplifier which controls the series element.

The basic circuit is common to all the high voltage supplies. The number of voltage multiplier stages and the polarity of the diodes in the multiplier are changed to produce the required output voltage.

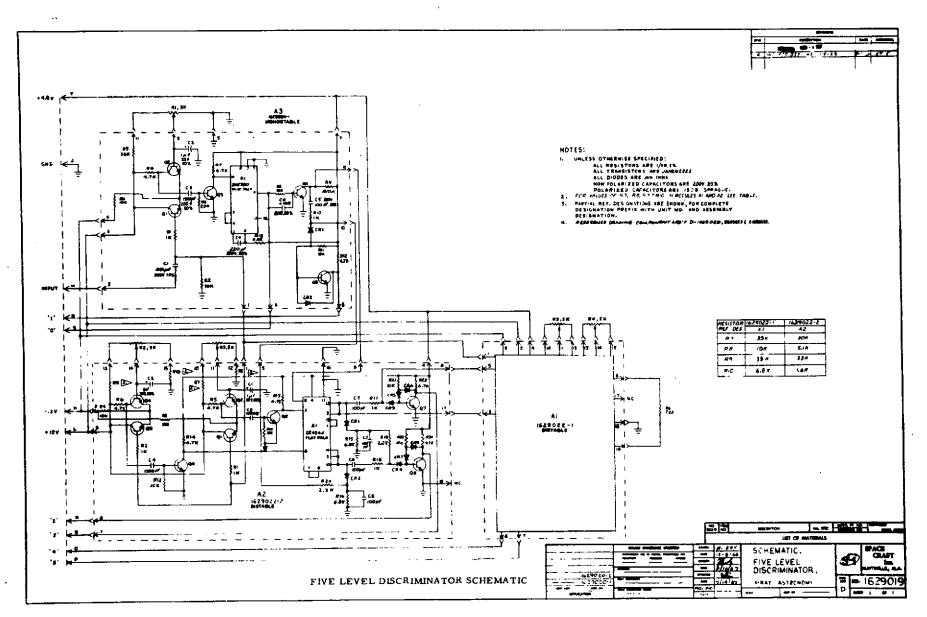


FIGURE 4.3-2

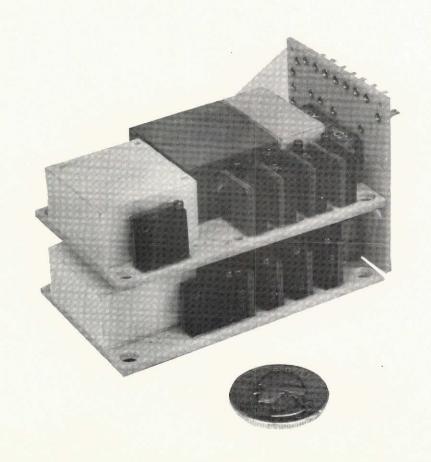
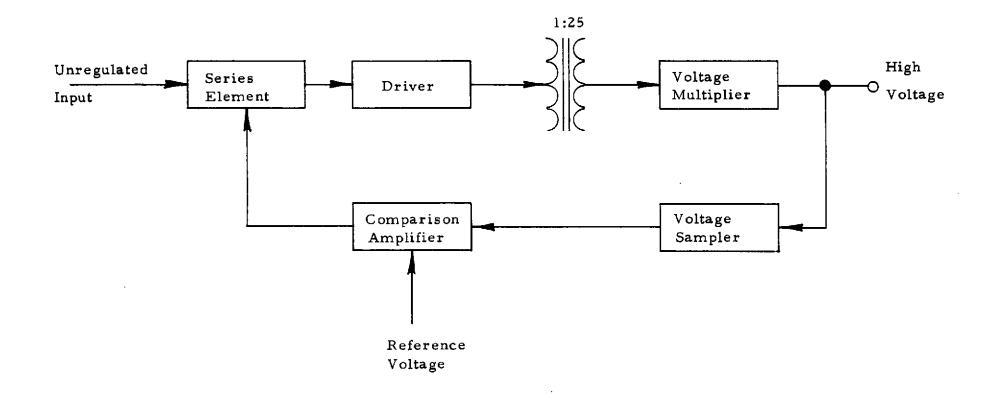


FIGURE 4.3-3

PROPORTIONAL COUNTER FIVE-LEVEL DISCRIMINATORS (X-RAY ASTRONOMY EXPERIMENT)



BLOCK DIAGRAM HIGH VOLTAGE CONVERTER & REGULATOR S-027 X-RAY ASTRONOMY EXPERIMENT FIGURE 4.4-1

Schematics of the +2500 VDC supply used with the proportional counters, the -2500 VDC supply used with the star tubes and the -1000 VDC supply used with the Fluor Guard phototubes are shown in figures 4.4-2, 4.4-3 and 4.4-4 respectively.

4.5 THRESHOLD DISCRIMINATOR

Figure 4.5-1 is a photograph of the Threshold Discriminator Assembly. A schematic of the Threshold Discriminator is shown in figure 4.5-2. There are six identical circuit modules on the board which are wired together to produce a single output signal. The assembly will accept six separate inputs and produce an output pulse with an input signal on one or more of the inputs. Each of the modules has an adjustable threshold level over a selected range. Each module consists of an adjustable comparator with two one-shot modules connected in series to produce a blanking pulse.

4.6 ANALOG SIGNAL CONDITIONER

The analog signal conditioner consists of two printed circuit boards and has a twenty-five channel capability for conditioning data for acceptance by the analyzers. In addition to the twenty-five active channels, there are five supplementary channels provided to monitor temperatures in certain portions of the experiment by the Ground Support Equipment during experiment checkout.

Each channel is conditioned to produce an output from zero to five volts d.c. with a source impedance of 10,000 ohms maximum. Schematics of the analog boards are shown in figures 4.6-1 and 4.6-2.

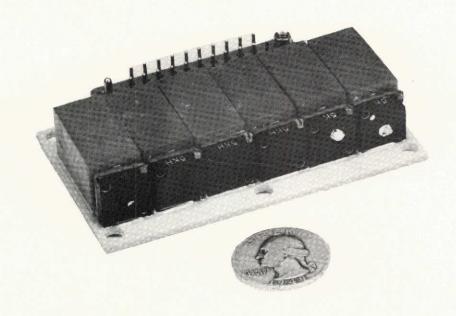
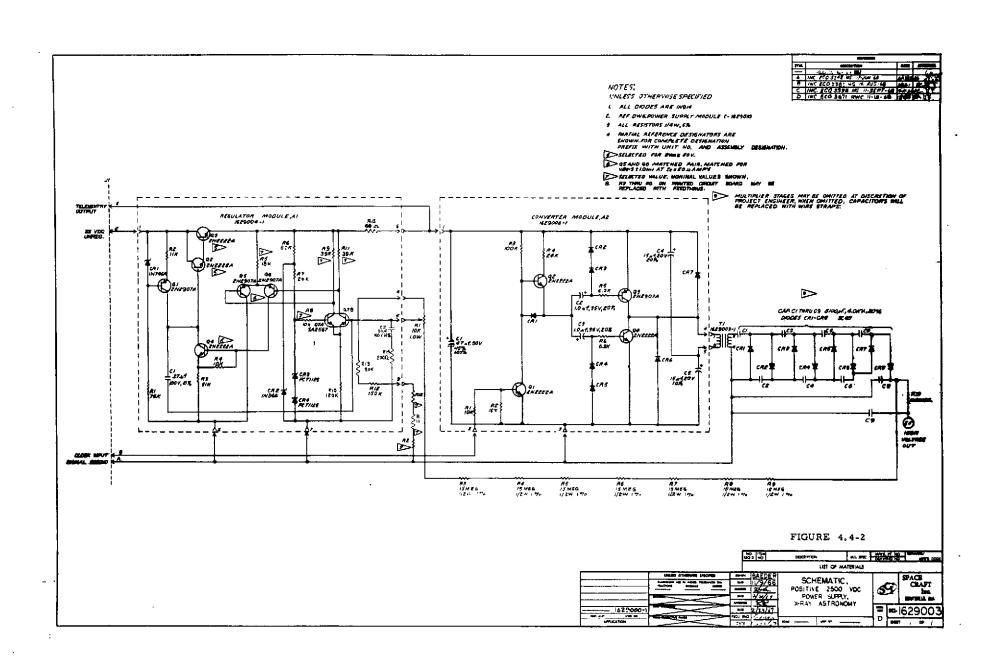
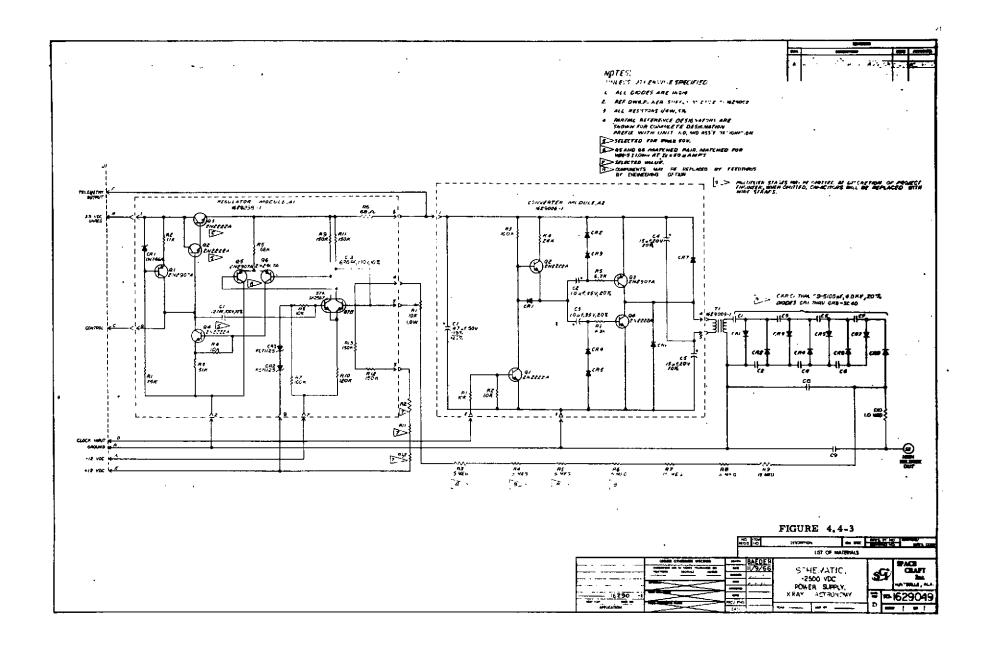
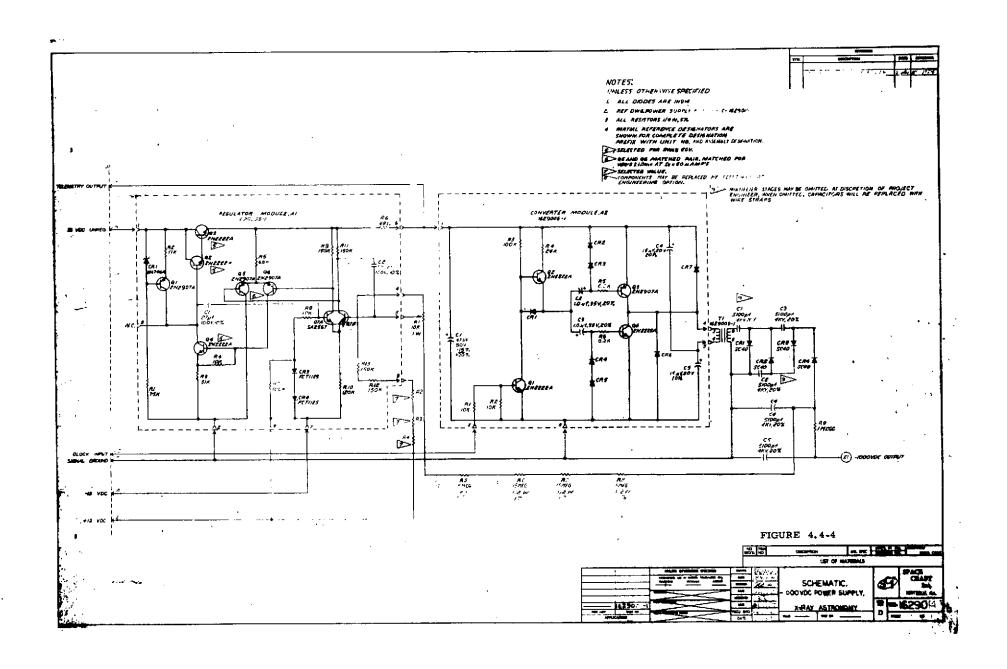
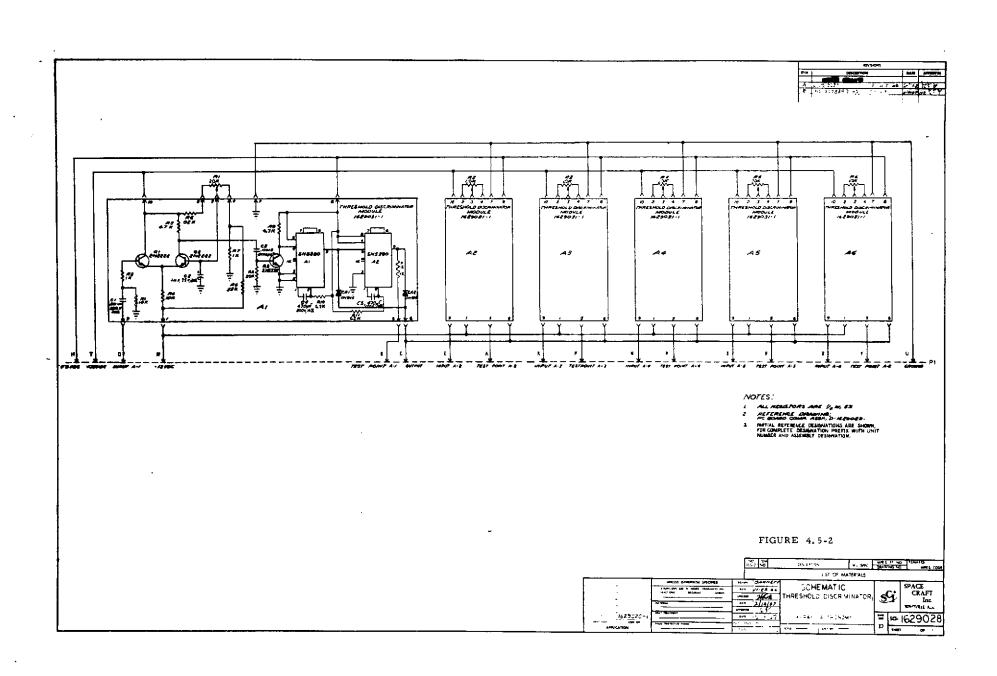


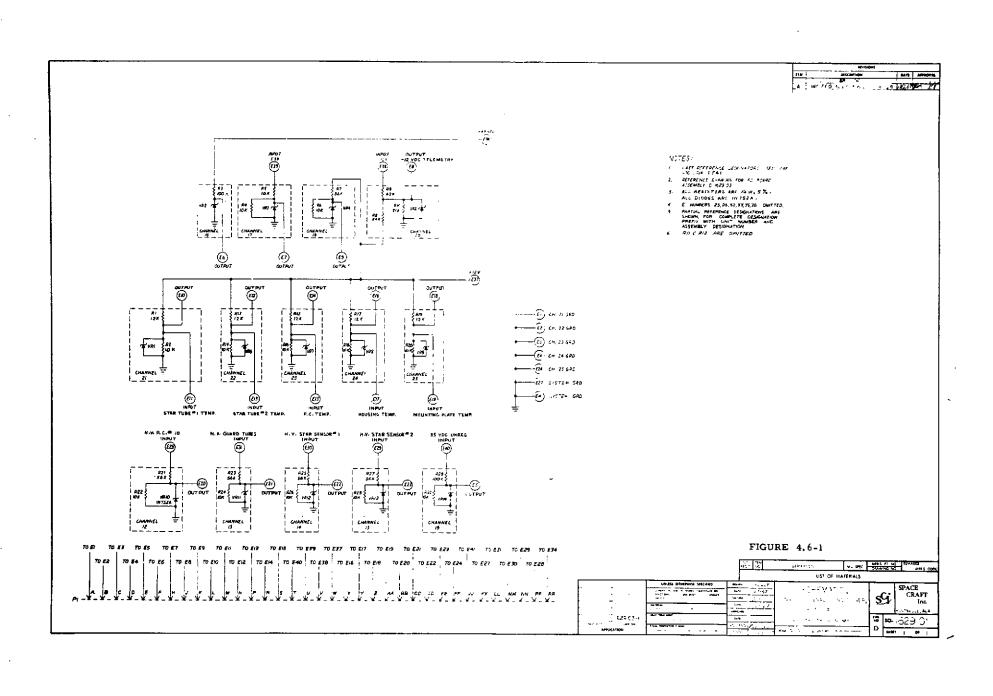
FIGURE 4.5-1

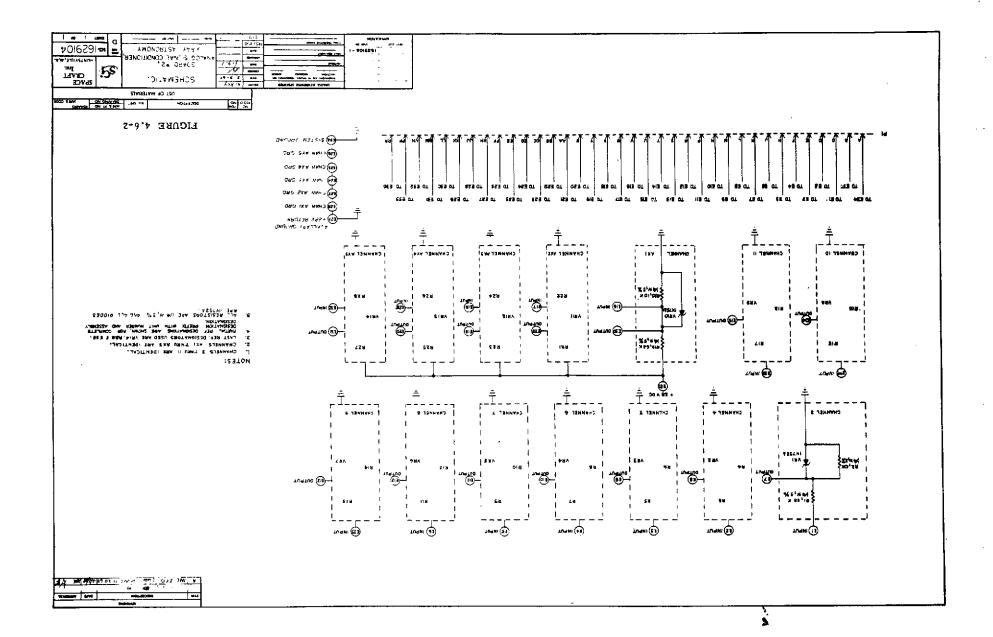












4.7 STAR SENSOR AMPLIFIERS

A photograph of the star sensor amplifier is shown in figure 4.7-1 and a schematic is shown in figure 4.7-2.

The assembly consists of an Electrometer module and a Buffer Amplifier module.

The Electrometer Module will effectively measure a current as low as 5×10^{-12} amps producing an output of 5 millivolts. The electrometer achieves good stability by the use of differential field-effect devices and exhibits a high input impedance to prevent loading of the photomultiplier tubes.

A high intensity light protection circuit is included in the electrometer and utilizes the property that the voltage output of the electrometer is proportional to the current from the tube.

To prevent solar electrical damage to the tube, prevent tube saturation and limit the tube's recovery time from high light levels, the tube's output is held to a constant current of 10^{-8} amps. The equivalent electrometer output (about 6 volts) is returned through a linear amplifier to a control line in the voltage regulation section of the H. V. power supply. When tube current reaches 10^{-8} amps the regulator loop will maintain this tube output current through reduction of the tube's current gain by decreasing the high voltage into the tube.

The Buffer Amplifier module is directly coupled to the electrometer output and has a switchable gain which provides a x 10 gain for low level signals and a xl gain for higher levels which effectively extends the dynamic range about three orders of magnitude.

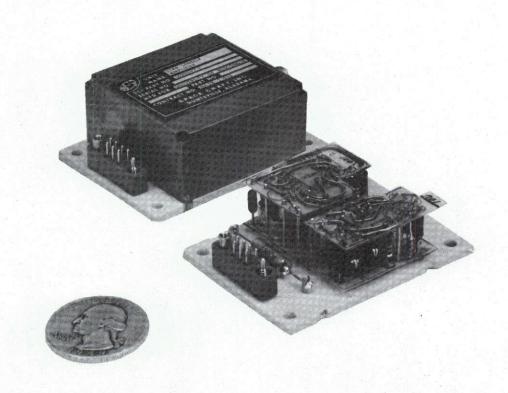
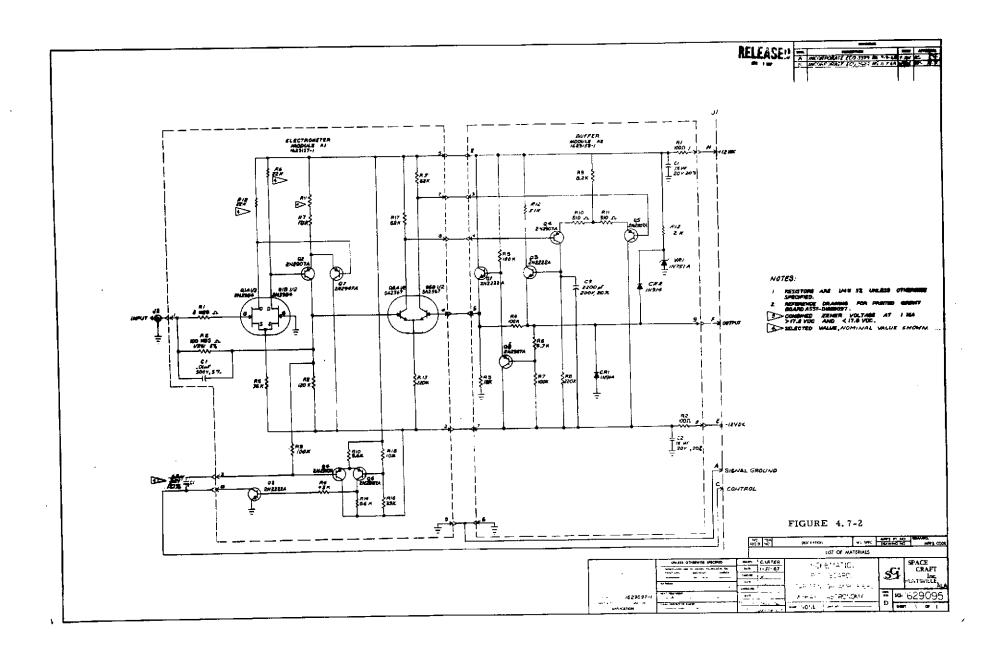


FIGURE 4.7-1

STAR SENSOR AMPLIFIER, BEFORE AND AFTER ASSEMBLY (X-RAY ASTRONOMY EXPERIMENT)



4.8 LOW VOLTAGE POWER SUPPLY

All voltages required in the S-027 experiment are developed in the Low Voltage Power Supply from the spacecraft +28 volt bus. A photograph, block diagram, and schematics of the supply are shown in figures 4.8-1 thru 4.8-5. The supply provides experiment power isolated from the +28 volt system by chopping and transformer coupling the primary voltage. The transformer has multiple secondary windings which are regulated and filtered to provide the final outputs to the experiment. In addition to providing the experiment voltages of ± 12 Vdc, +35 Vdc, +4 Vdc and +5.5 Vdc the supply generates a 5 kHz, 3 Vpp square-wave clock for the high voltage power supplies.

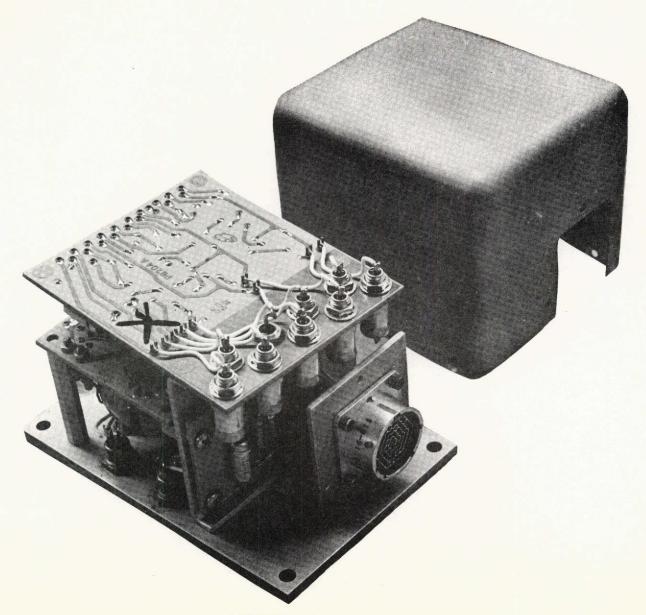
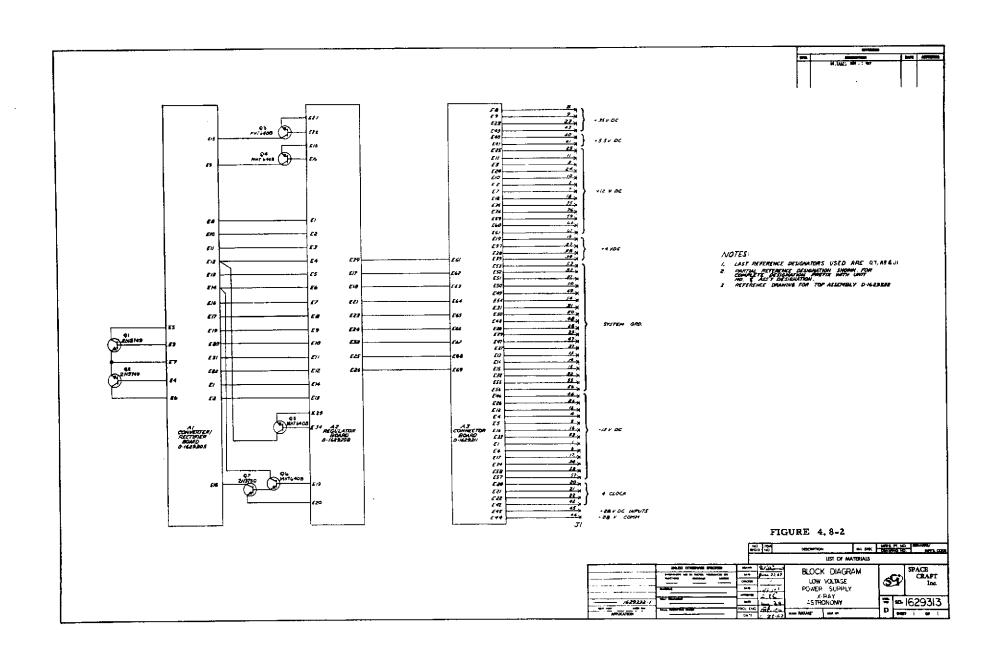
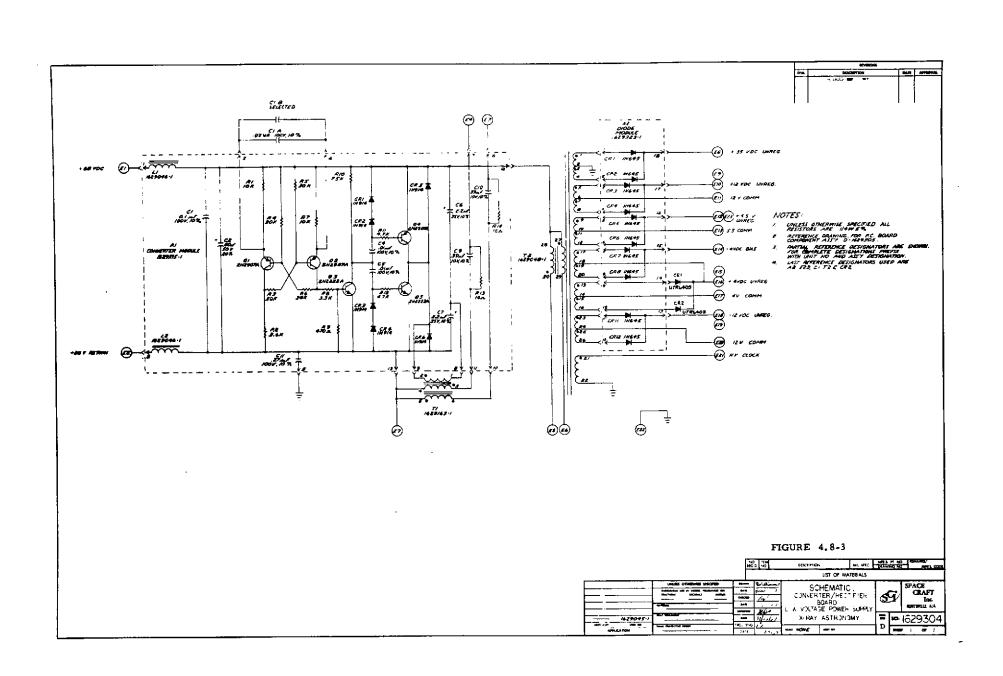
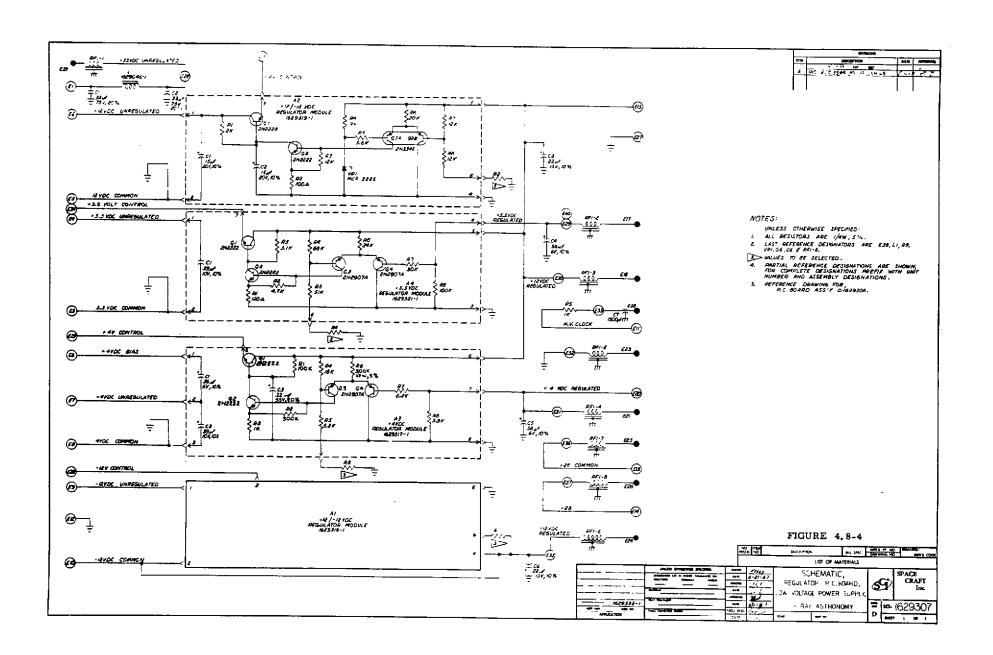
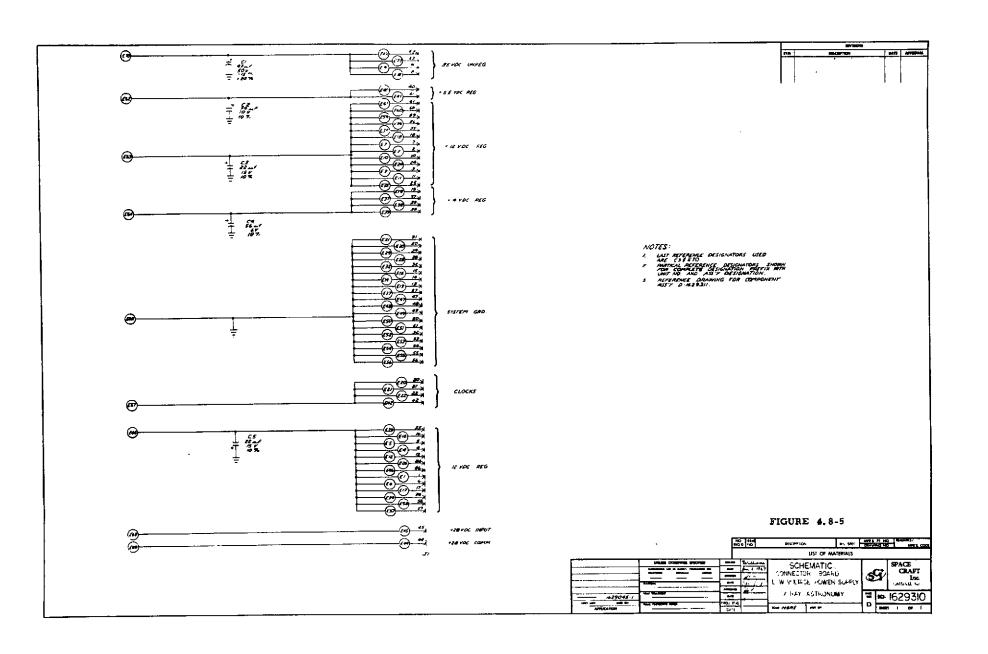


FIGURE 4.8-1
S-027 X-RAY ASTRONOMY EXPERIMENT
LOW VOLTAGE POWER SUPPLY









5.0 ENVIRONMENTAL TEST

The S-027 Qualification Unit was subjected to environmental test per NASA Approved Acceptance Test Procedures.

In addition to test performed on the completed experiment, each subassembly was subjected to appropriate environmental test and qualified prior to installation in the experiment.

The experiment was subjected to the following tests:

- (1) Acoustic
- (2) Acceleration
- (3) Thermal Shock
- (4) Thermal Vacuum
- (5) Humidity
- (6) Vibration
- (7) R.F.I.

5.1 ACOUSTIC TESTS

The experiment was mounted in a reverberant test chamber with resilient cord and was exposed to a low level test spectrum of 146.5 db for three minutes. The experiment was then subjected to a 90 second high level test of 153.5 db. After the test the experiment functioned properly. A photograph of the Acoustic Test Set-up as shown in figure 5.1-1.

5, 2 ACCELERATION TEST

The experiment was mounted in a twenty-four foot rotary accelerator and accelerated to 10 G in both directions of all three axis. After the acceleration the experiment was tested and performed properly.

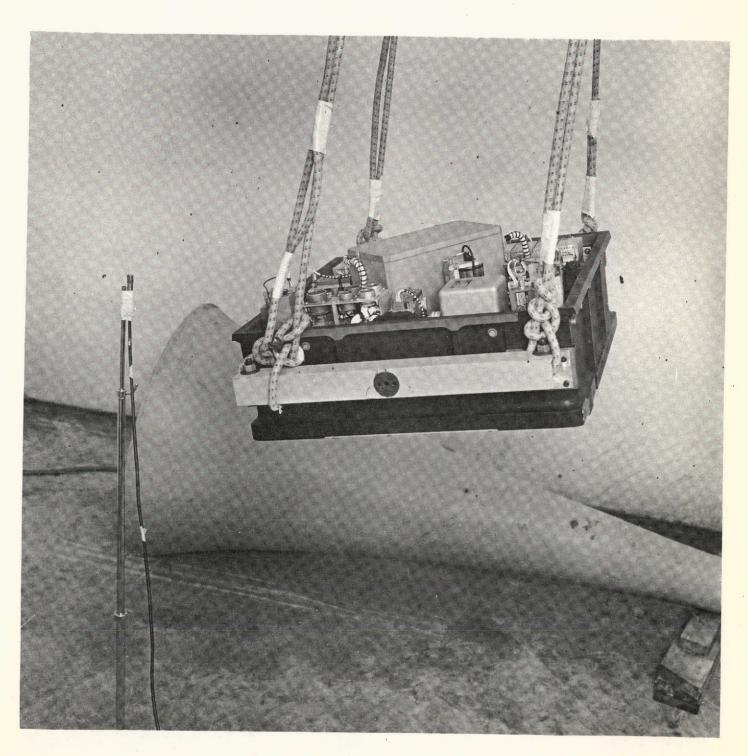


FIGURE 5.1-1

ACOUSTIC TEST SETUP

5.3 THERMAL SHOCK

The experiment, mounted in its shipping container, was subjected to three thermal shock cycles. Each cycle consisted of a four hour minimum soak at 60° C and then a four hour minimum soak at -40° C. After the third cycle the experiment was stabilized at ambient temperature and a functional test was conducted which indicated no malfunctions.

5.4 THERMAL VACUUM

The experiment was placed in a vacuum chamber and subjected to a thermal vacuum test at a simulated altitude of 400,000 feet. Infrared lamps were placed in the upper part of the chamber 15 inches above the experiment to simulate sunlight conditions. The counter windows were turned toward the infrared lamps. The chamber was raised in temperature while maintaining the 400,000 feet altitude and the chamber shroud was reduced to $+32^{\circ}F$. The infrared lamps were turned on for fifteen minutes maximum and then turned off for the remainder of the ninety minutes of the cycle. Four such cycles were completed for a total of five hours of tests.

After the hot cycle tests four cold cycle tests were completed for an additional five hours of test.

During the cold cycle while maintaining a 400,000 ft. altitude, the chamber shroud was reduced to -320°F and the infrared lamps were turned on for one minute. After this the lamps were turned off for the remainder of the ninety minute cycle.

After the cold cycle test the experiment was stabilized at ambient conditions and was found to be functioning properly. A photograph of the Thermal Vacuum test set up is shown in figure 5.3-1.

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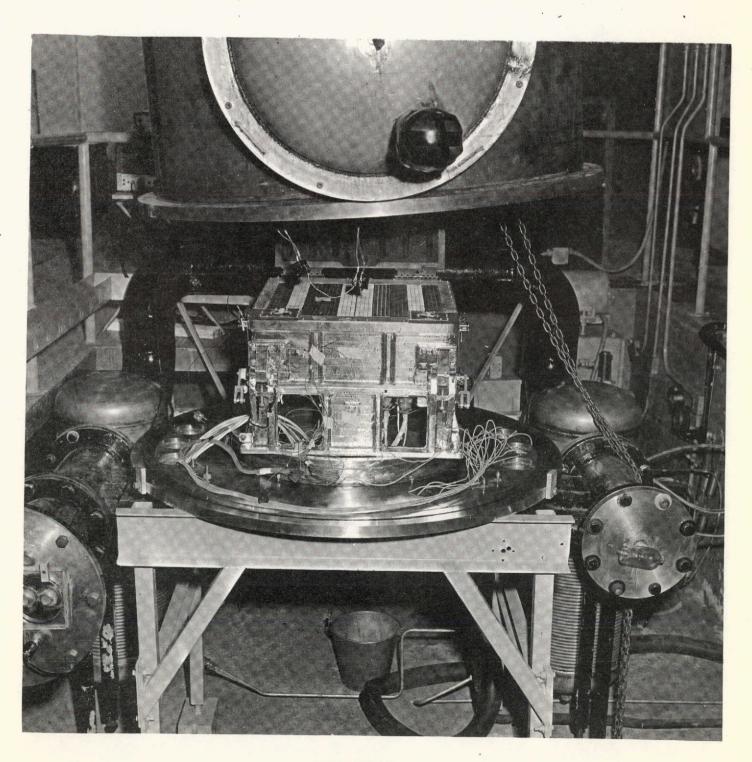


FIGURE 5.3-1

5.5 HUMIDITY TEST

The experiment was placed in a humidity chamber at room ambient conditions. The chamber ambient temperature and relative humidity were then increased to 37.2°C (99°F) and 50 percent respectively. This condition was maintained for six (6) hours at the conclusion of this period, the chamber ambient temperature was reduced to 24.4°C (76°F) and the relative humidity was increased to 95 $_{-0}^{+5}$ percent over a five (5) hour period. Then, over an eight hour period the chamber ambient temperature was reduced to 21.1°C (70°F) with a release of water as condensate and a relative humidity of 95⁺⁵₋₀ percent. When this condition was attained, the chamber ambient temperature was increased to 37.2°C (99°F) with a resultant decrease in the relative humidity to 41 percent. Then over a one hour period the relative humidity was increased to 50 percent. This procedure constituted one cycle. A total of five cycles were performed. Upon completion of the test, the specimen was returned to room ambient conditions and operationally tested with no malfunctions noted. A photograph of the Humidity Test Set-up is shown in figure 5.5-1.

5.6 VIBRATION TEST

The experiment was subjected to the vibration levels shown below.

Sine Vibration

5 - 62 Hz @ 0.03 inches DA Disp.

62 - 200 Hz @ 5,80 g!s (peak)

200 Hz to 2000 Hz @ 2.80 g's (peak)

The sine wave vibration was from 5 Hz to 2000 Hz and from 2000 Hz to 5 Hz at a sweep rate of one octave per minute.

PAGE NO.



HUMIDITY
Figure 5.5-1

Random Vibration

Composite = 11.55 grms

The random vibration duration was 5 minutes per axis. After vibration the unit was tested and found to be operational.

5.7 RFI TEST

The experiment was subjected to a Radio Frequency Interference Test per MIL-I-6181D, including broadband and narrowband conducted interference, broadband and narrowband radiated interference, and a susceptibility test including conducted and radiated Radio Frequency and conducted audio.

The unit was found to be within the allowable limits for each test with the exception of Broadband radiated interference which was found to be out of the allowable limits by 11 db at 200 kHz.

Photographs of the test set-ups are shown in figures 5.7-1, 5.7-2 and 5.7-3.

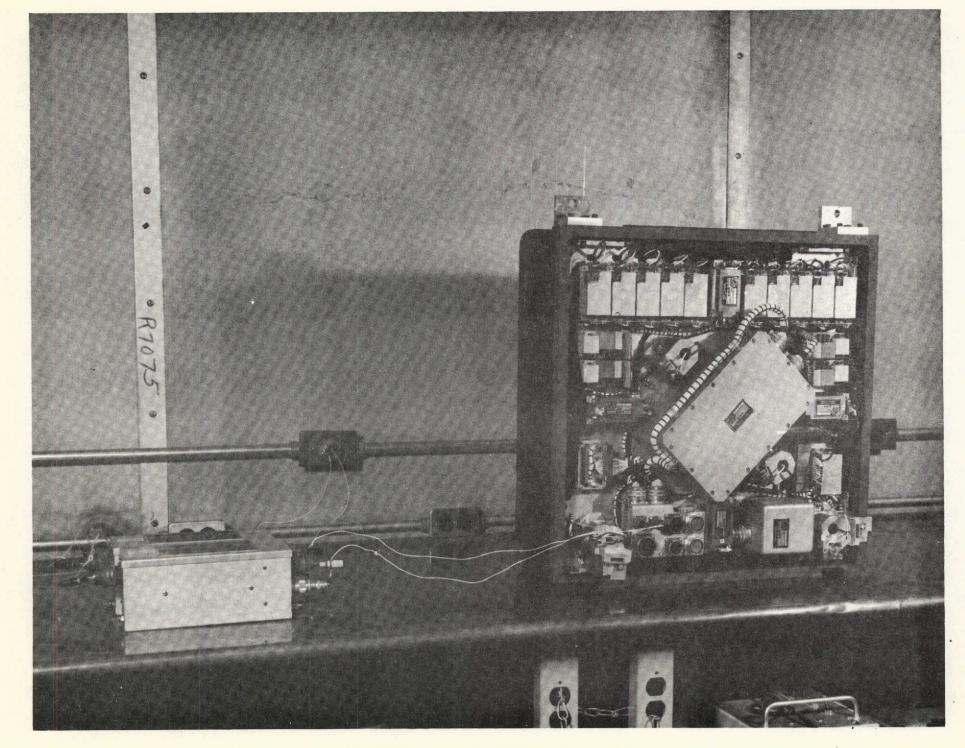


FIGURE 5.7-1 - CONDUCTED INTERFERENCE TEST SET UP

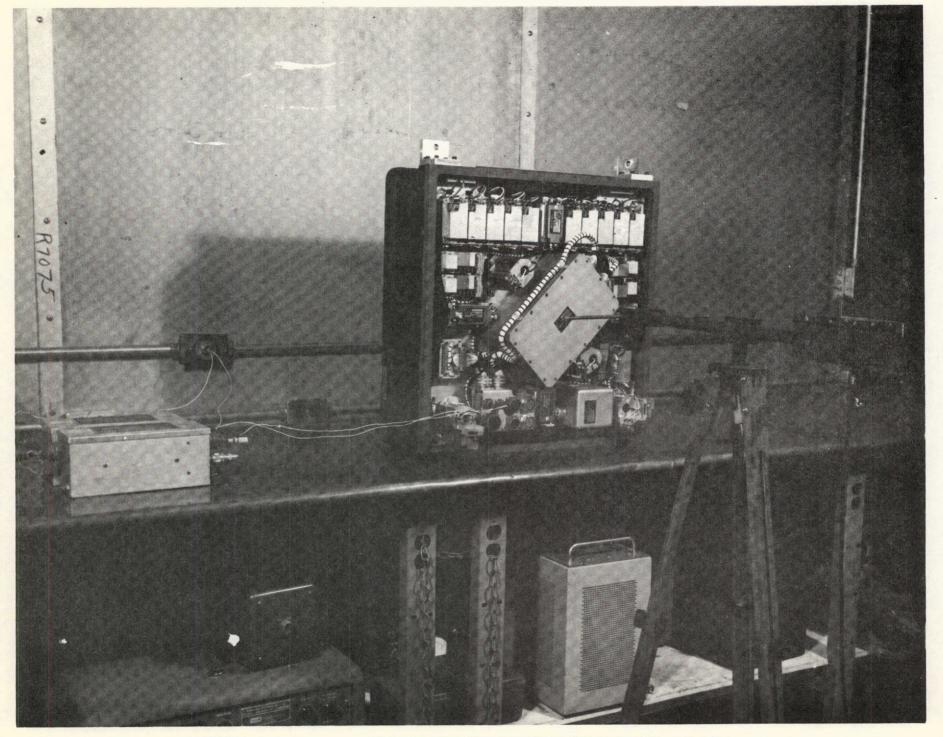


FIGURE 5.7-2 - RADIATED INTERFERENCE TEST SET UP

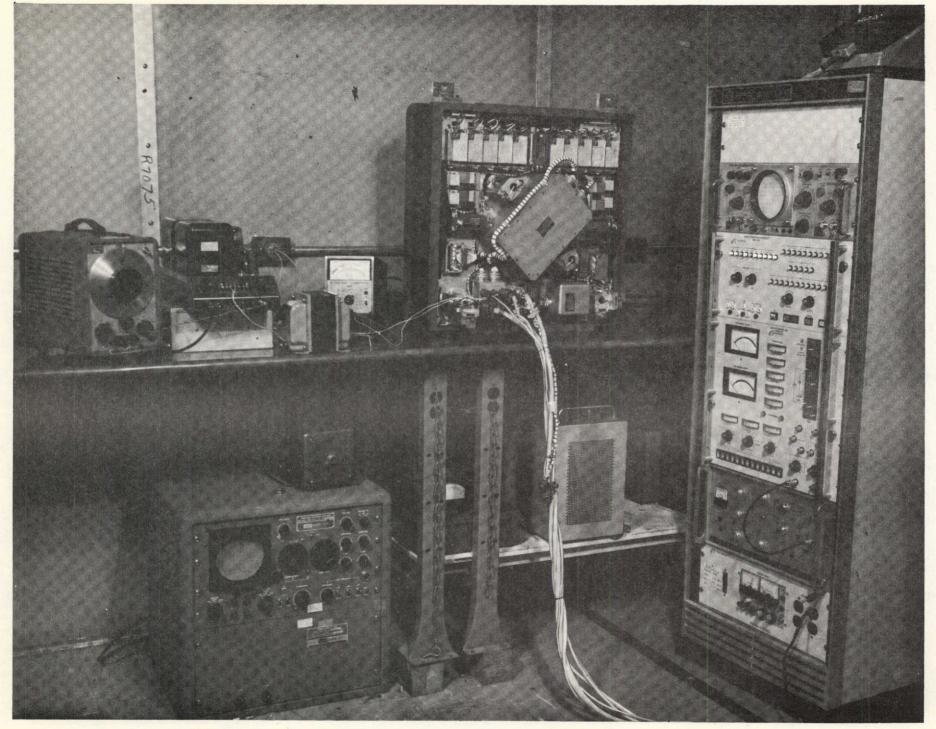


FIGURE 5.7-3 - AUDIO FREQUENCY TEST SET UP

6.0 GROUND SUPPORT EQUIPMENT

Two identical Ground Support Equipment consoles were built for the S-027 experiment. A photograph of one of the consoles is shown in figure 6.0-1. Each console contains an oscilloscope, a 128 channel analyzer, an analog processing and display unit, a digital processing and display unit and a system power supply. In addition to the equipment contained in the console the Ground Support Equipment includes a Strip Chart Recorder, a Pulse Generator and a Line Printer. The cable diagram shown in figure 6.0-2 shows the interconnects of the various equipment to the experiment.

The Digital and Analog Processing Units interface with the experiment and are the heart of the Ground Support Equipment. These units will be discussed further in the following section.

6.1 ANALOG PROCESSING AND DISPLAY UNIT

The Analog Processing Unit provides displays for the twenty-five analog data channels in the form of meter read-outs and GO/NO GO indicator lights. Each channel is also routed to a patch board to allow recording the data on external recorders. The five supplemental analog measurements which are not active channels in the experiment, but are included to provide additional temperature measurements to the Ground Support Equipment are also displayed on the analog panel. Since these five channels are not active experiment channels, the analog unit provides power to the measuring functions as required.

A set of schematics of the Analog Panel is included in figures 6.1-1 thru 6.1-8.

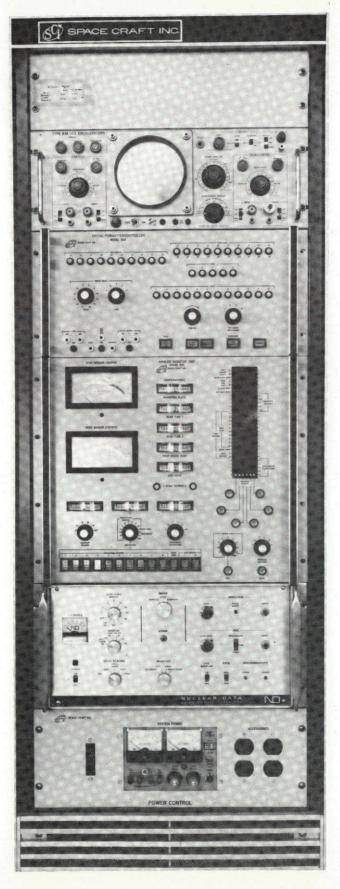
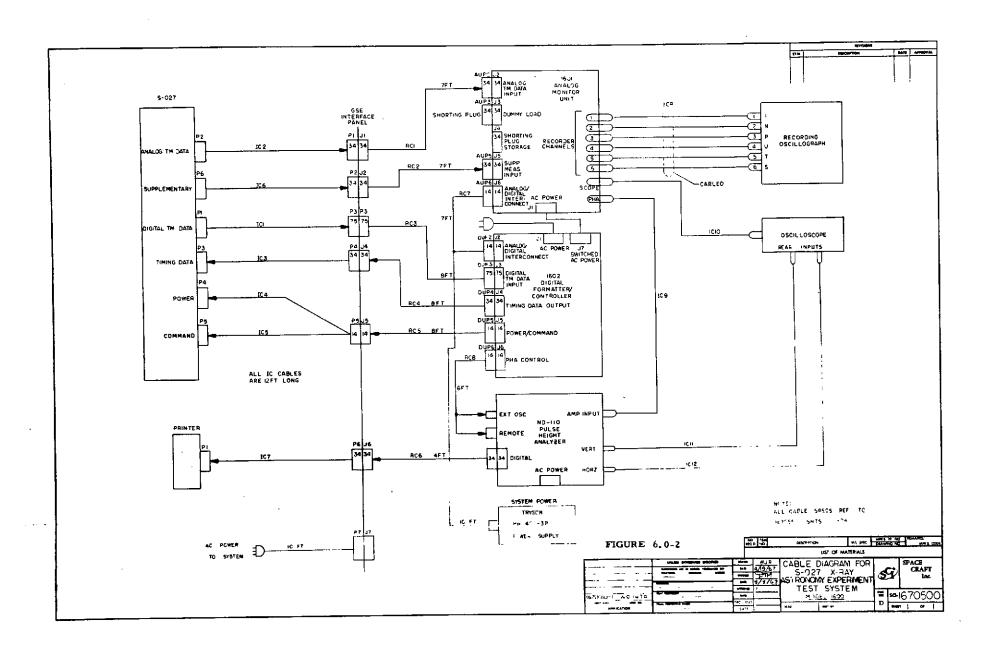
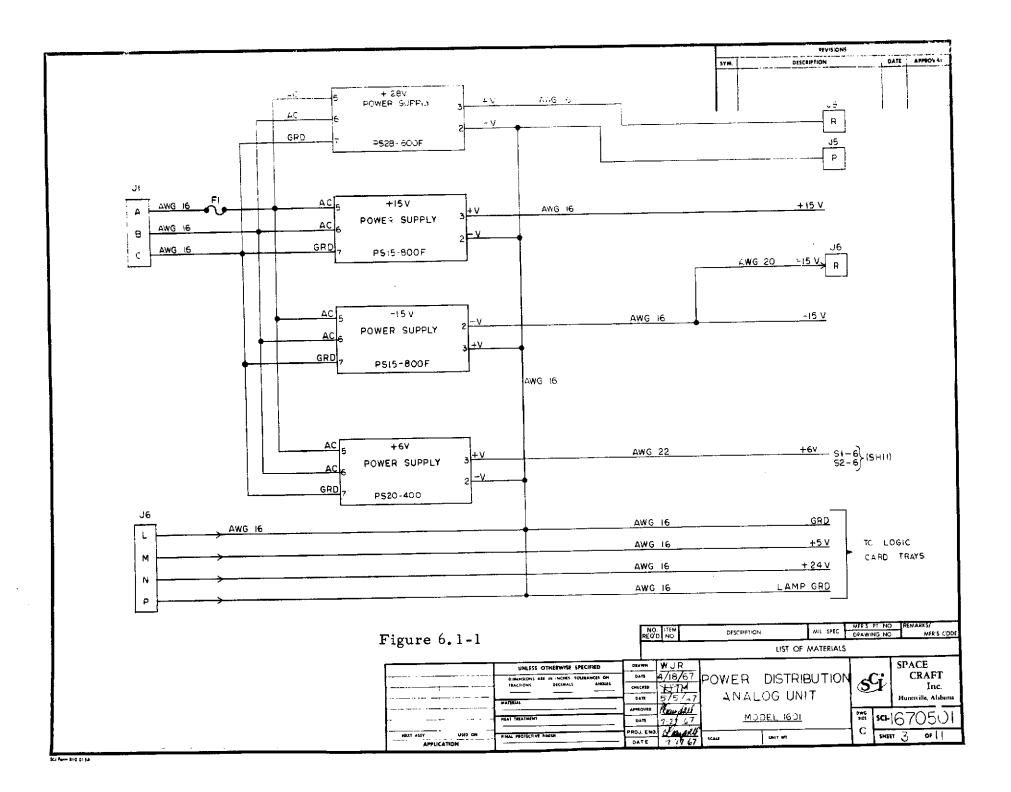
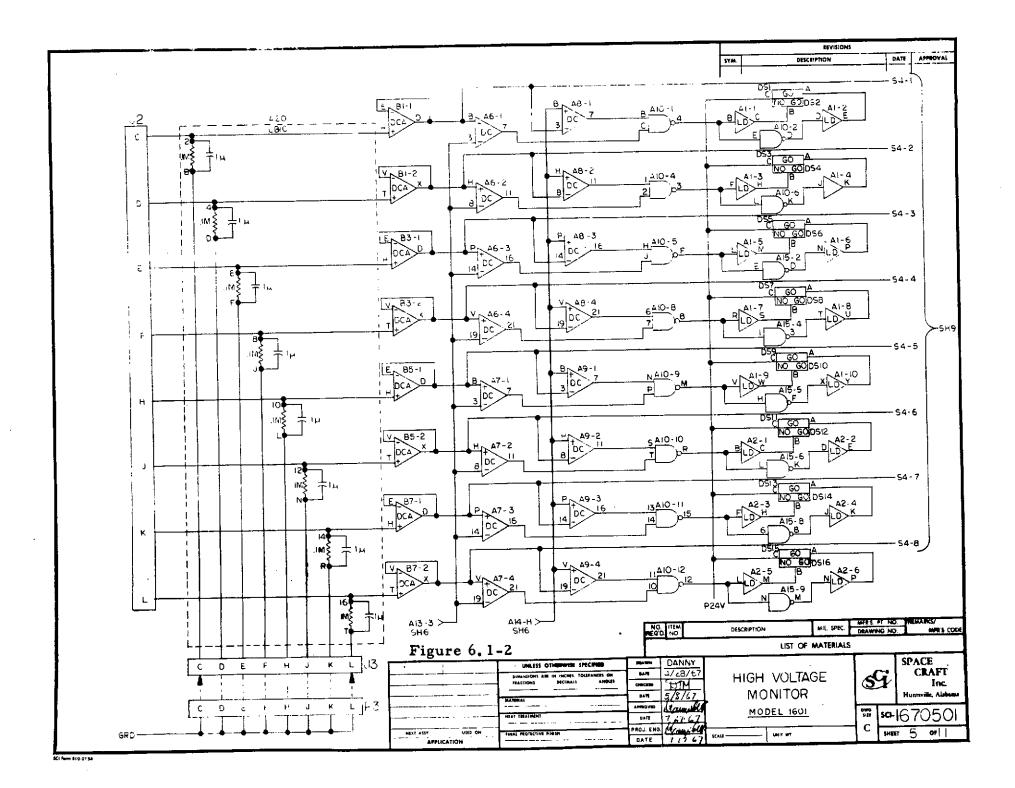
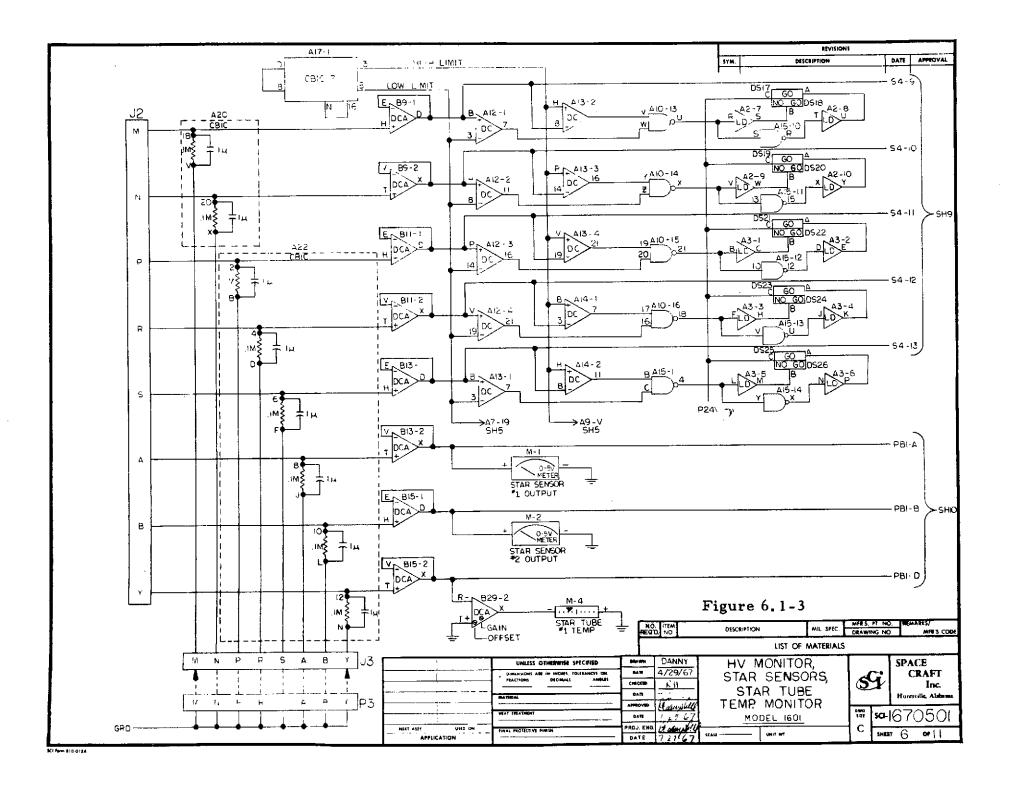


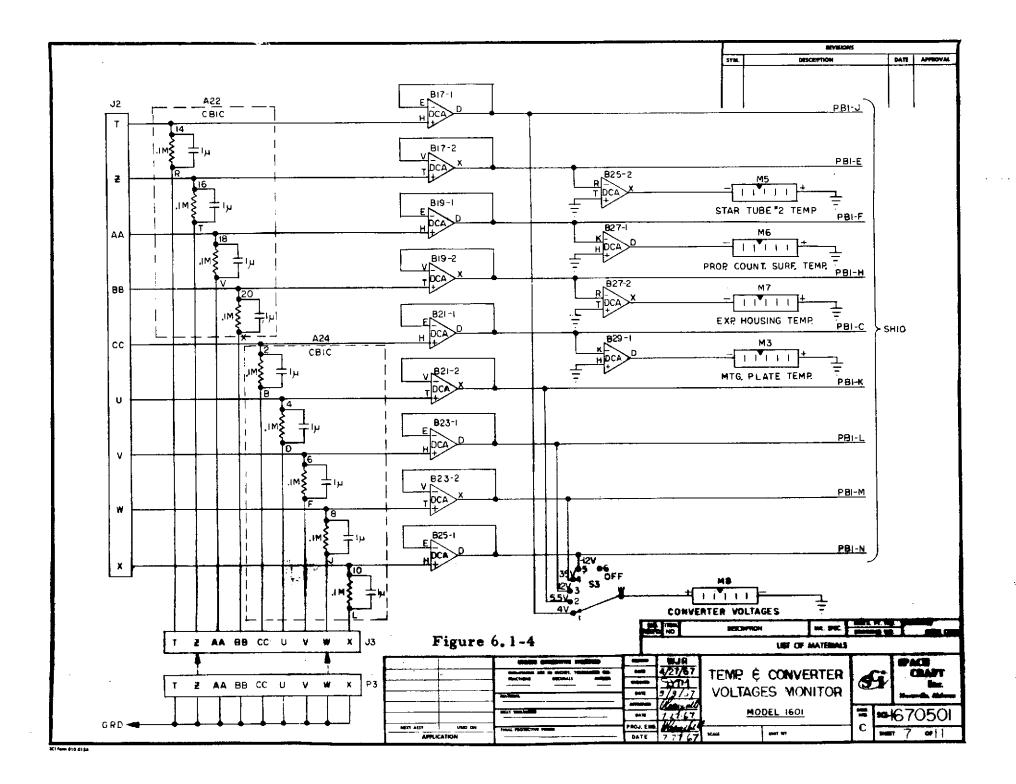
FIGURE 6.0-1
GROUND SUPPORT EQUIPMENT,
X-RAY ASTRONOMY EXPERIMENT

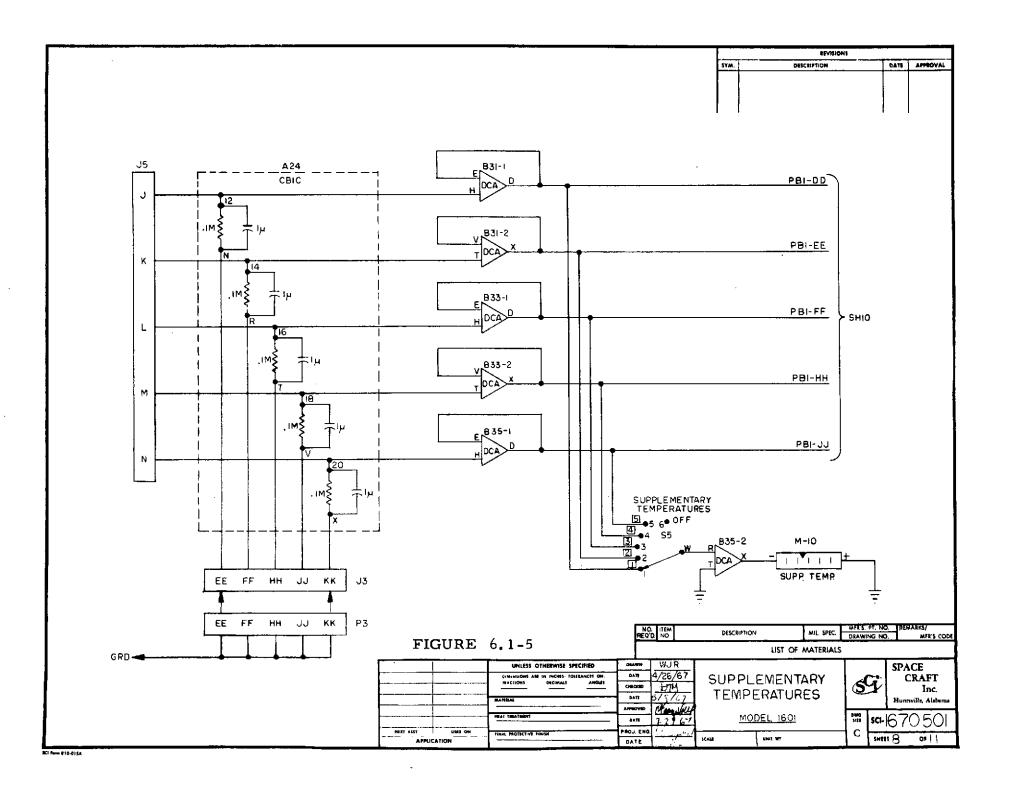


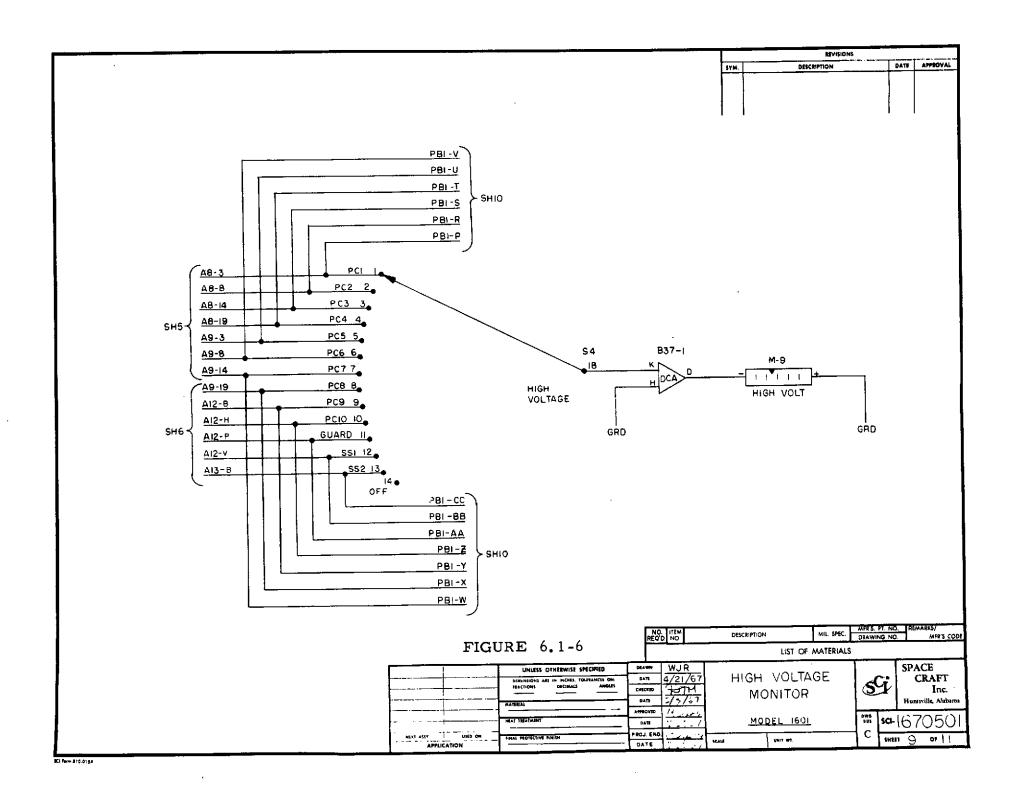


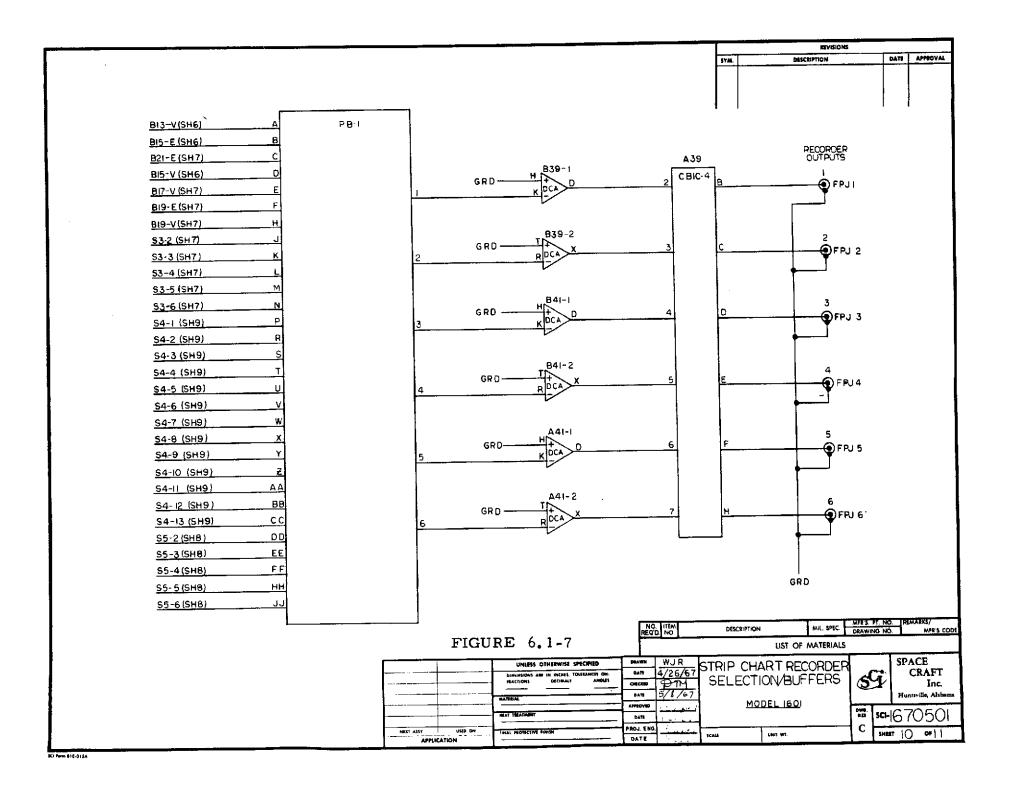


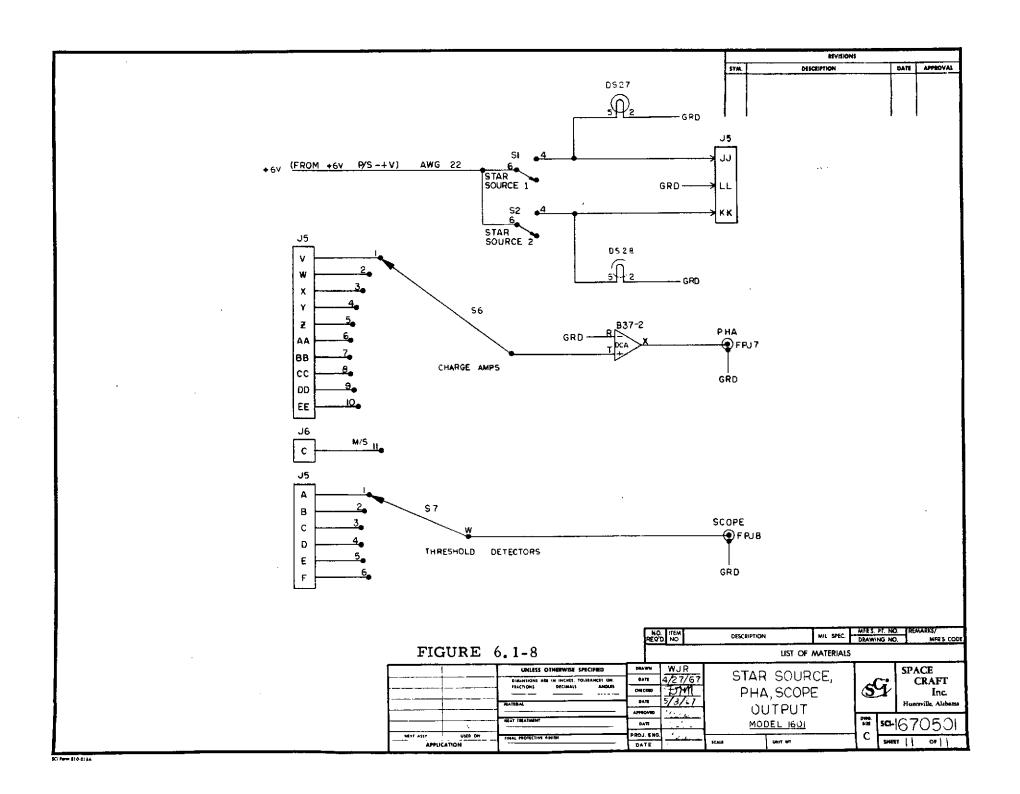












6.2 DIGITAL PROCESSING AND DISPLAY UNIT

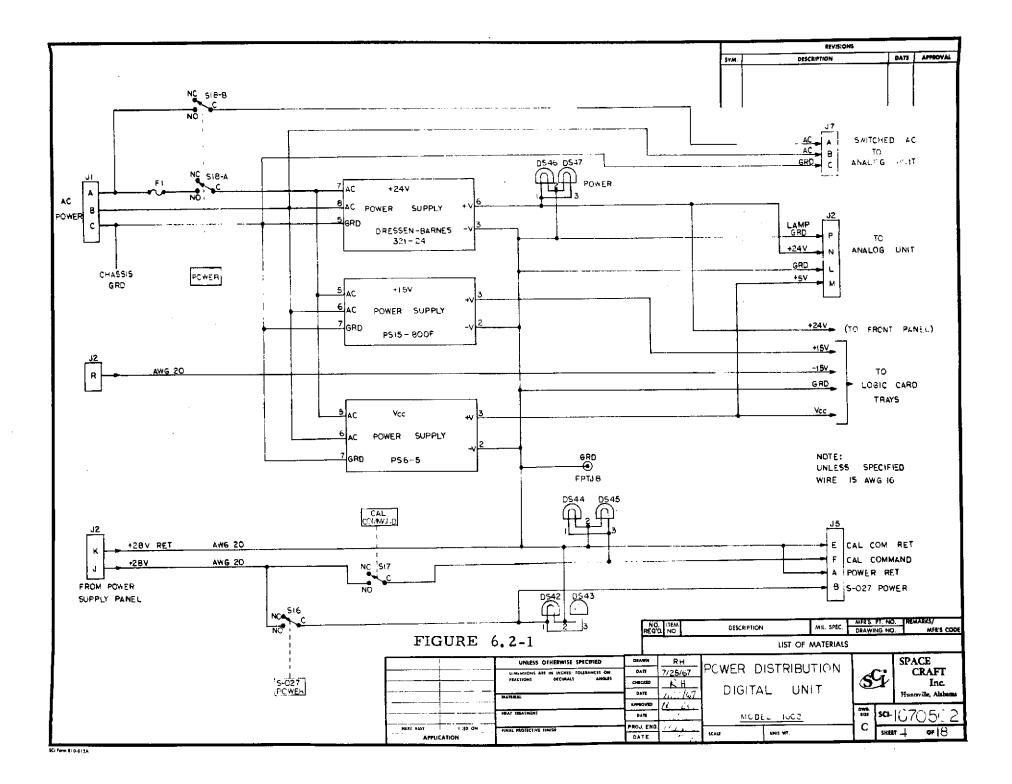
The digital unit provides information to the experiment Digital Data

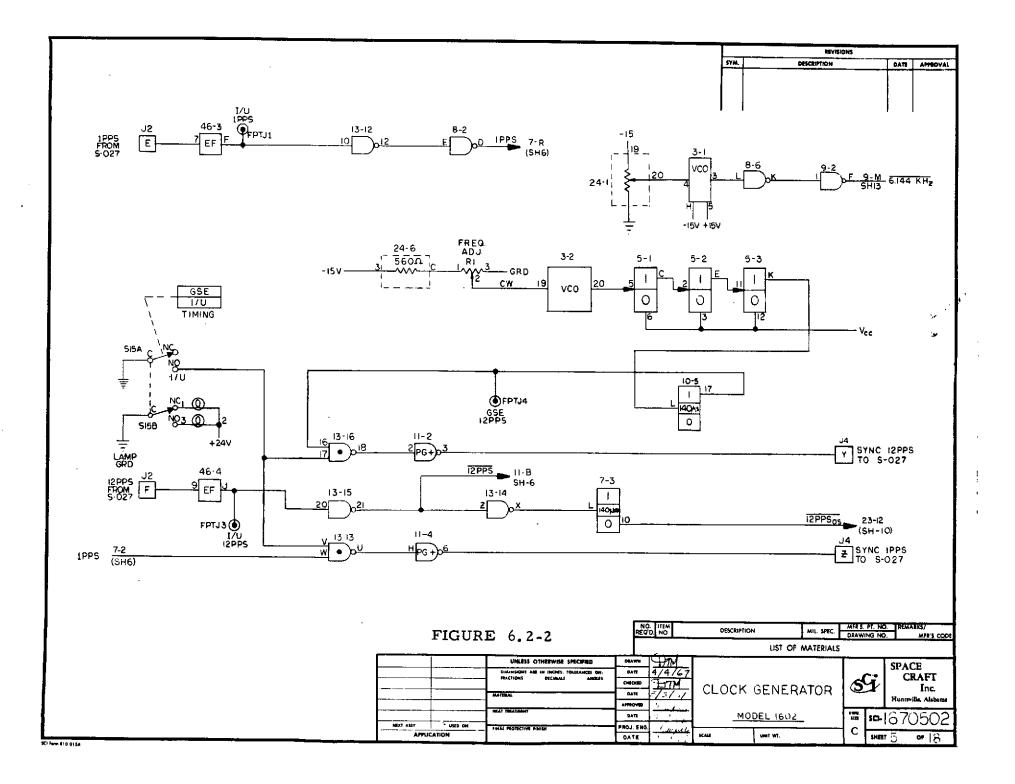
Processor which is normally provided by the launch vehicle instrument
unit such as timing and synchronization pulses. The digital outputs from
the experiment are analyzed and displayed by lights on the Digital Front
Panel.

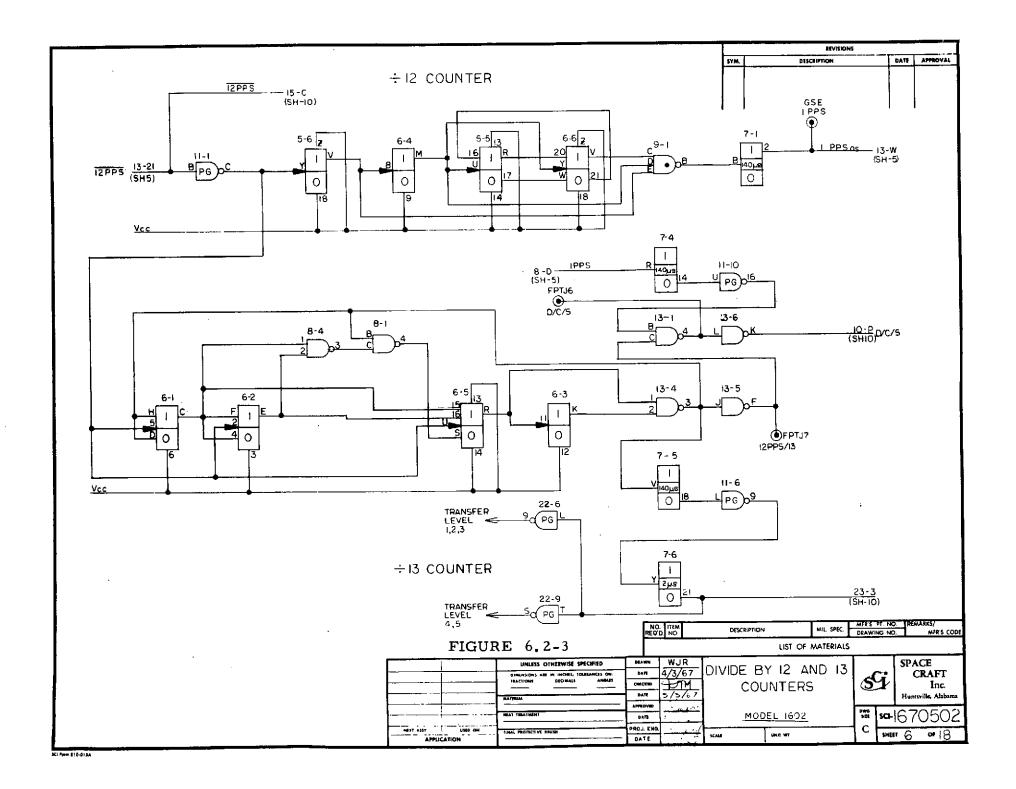
Selector switches are included to allow selection and display of any of the twelve data groups and any of the five-ten bits words contained in each data group.

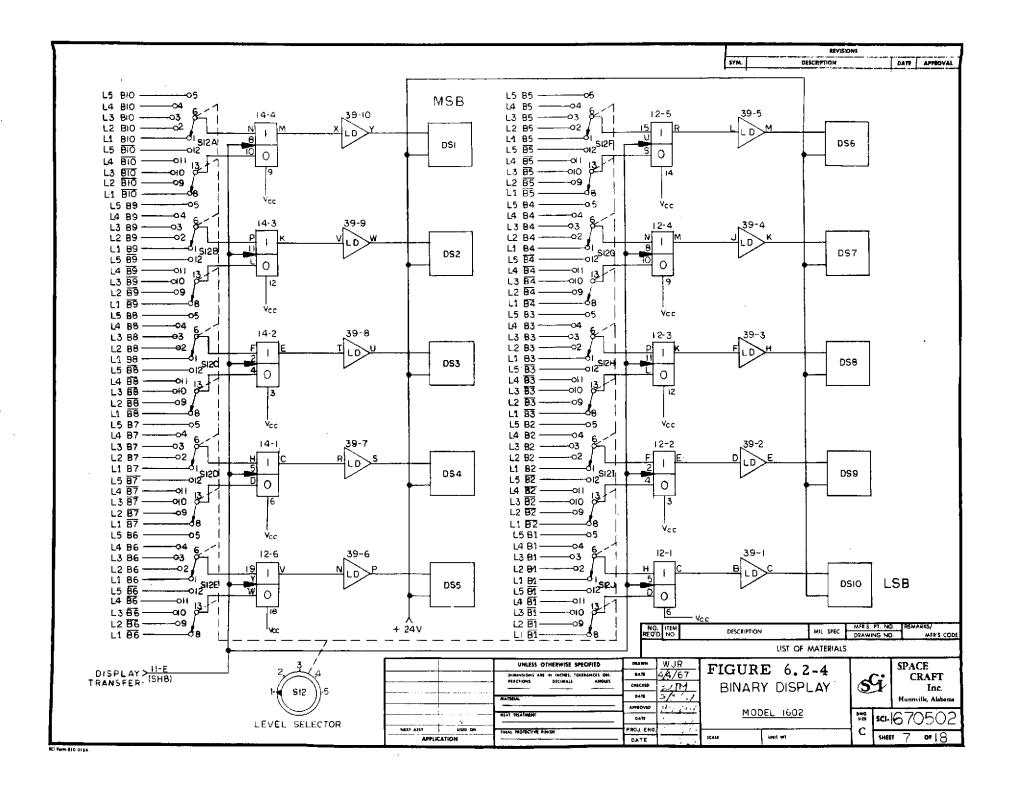
In addition to the digital data display, commands to apply experiment power and to calibrate the experiment originate in the unit and are activated by lighted pushbutton switches.

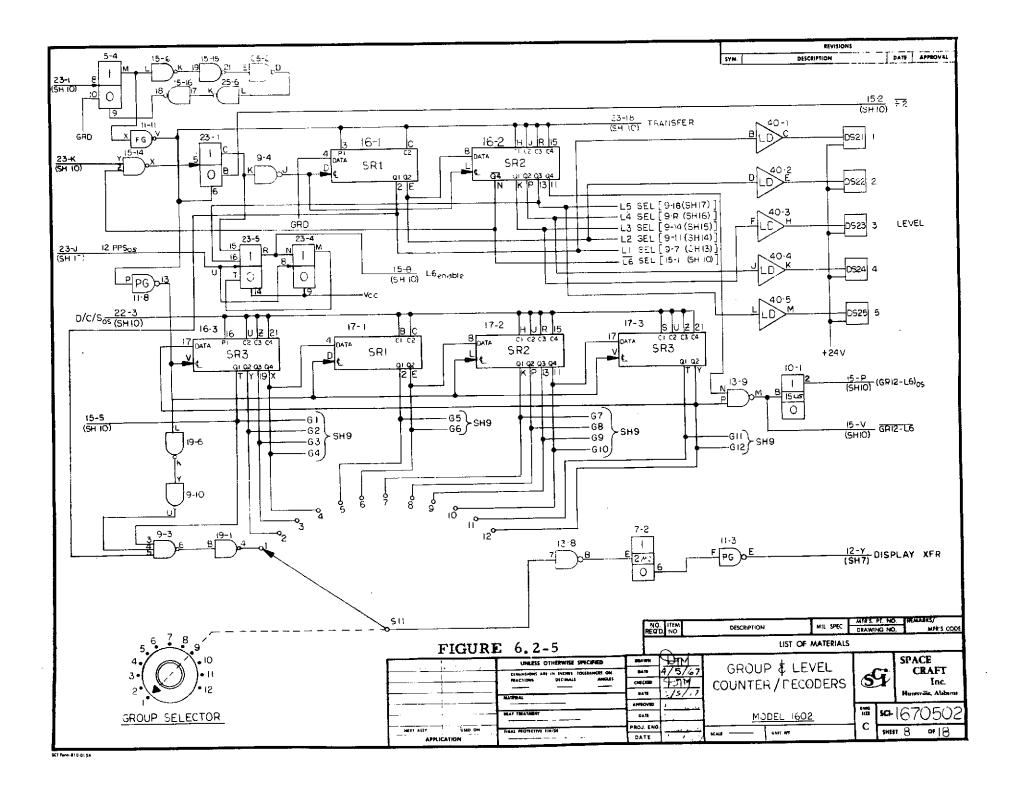
A set of schematics of the Digital Unit is included in figures 6.2-1 thru 6.2-15.

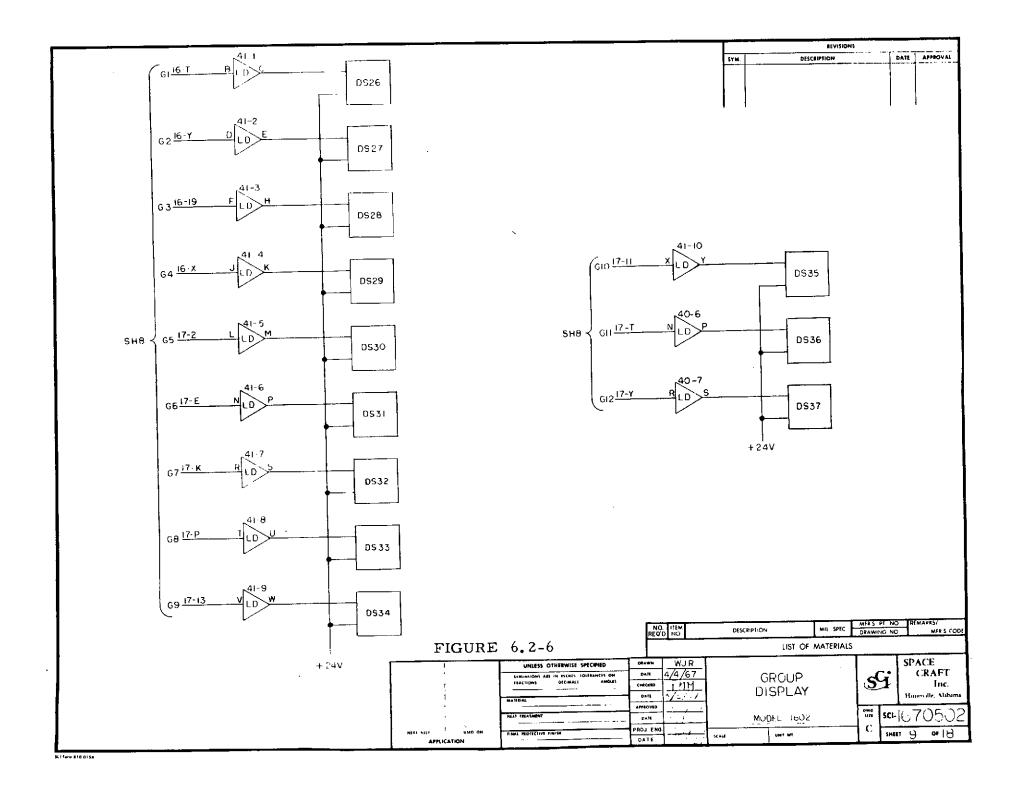


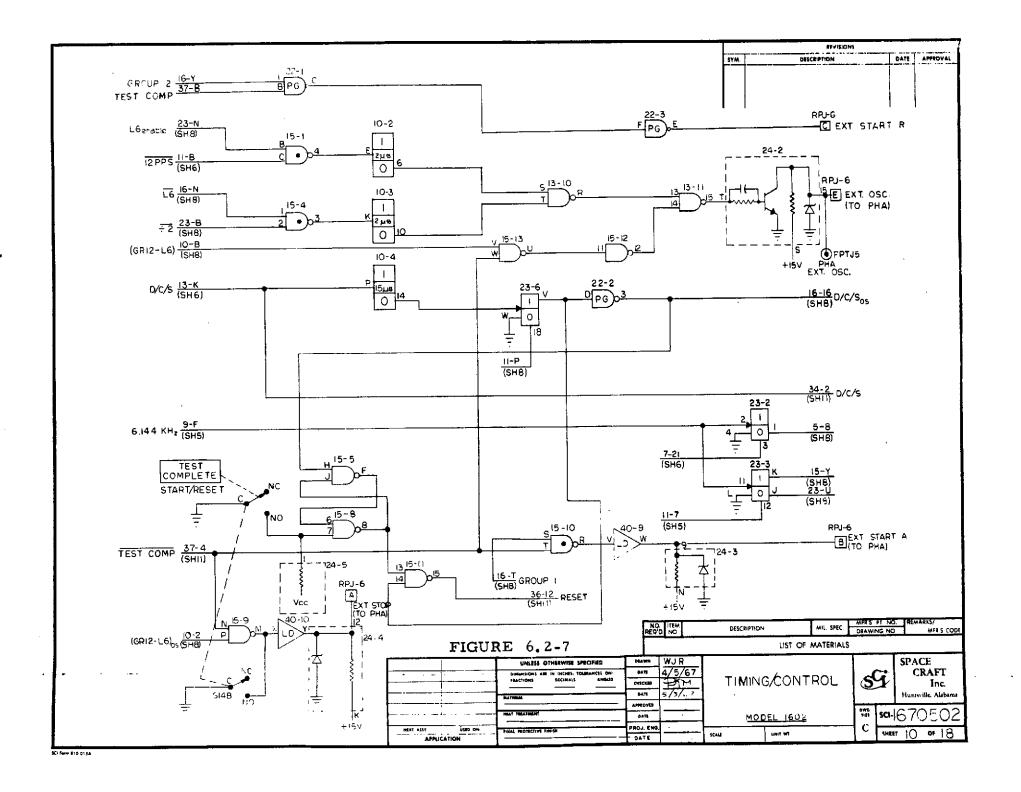


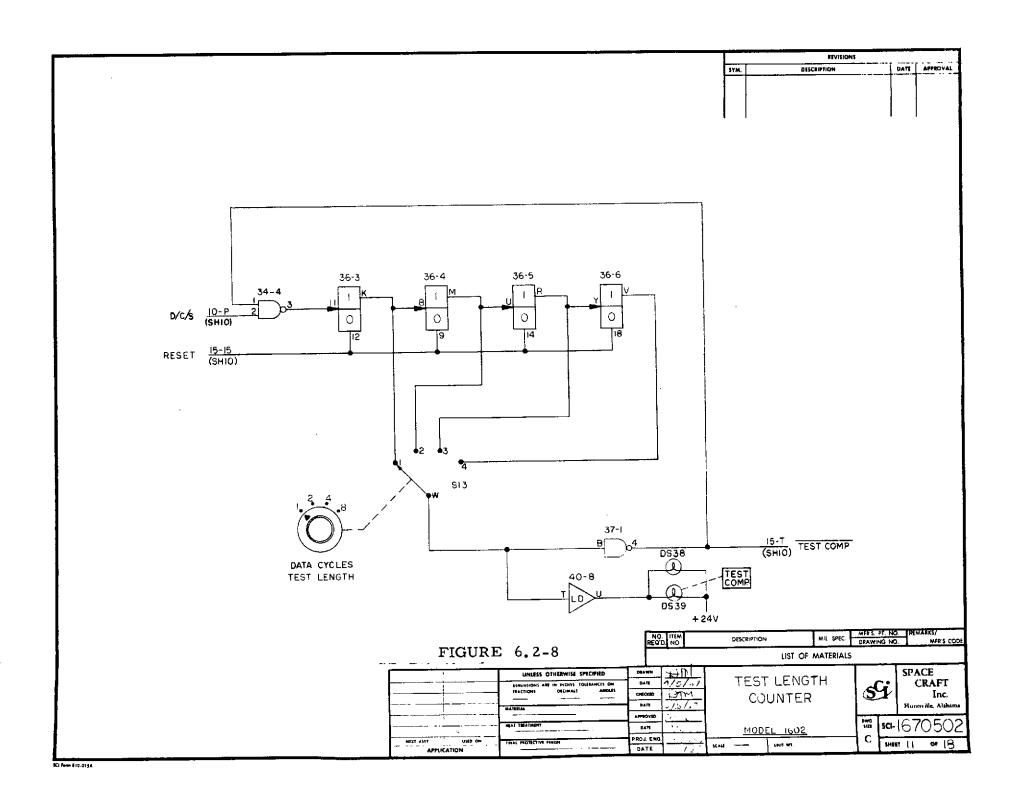


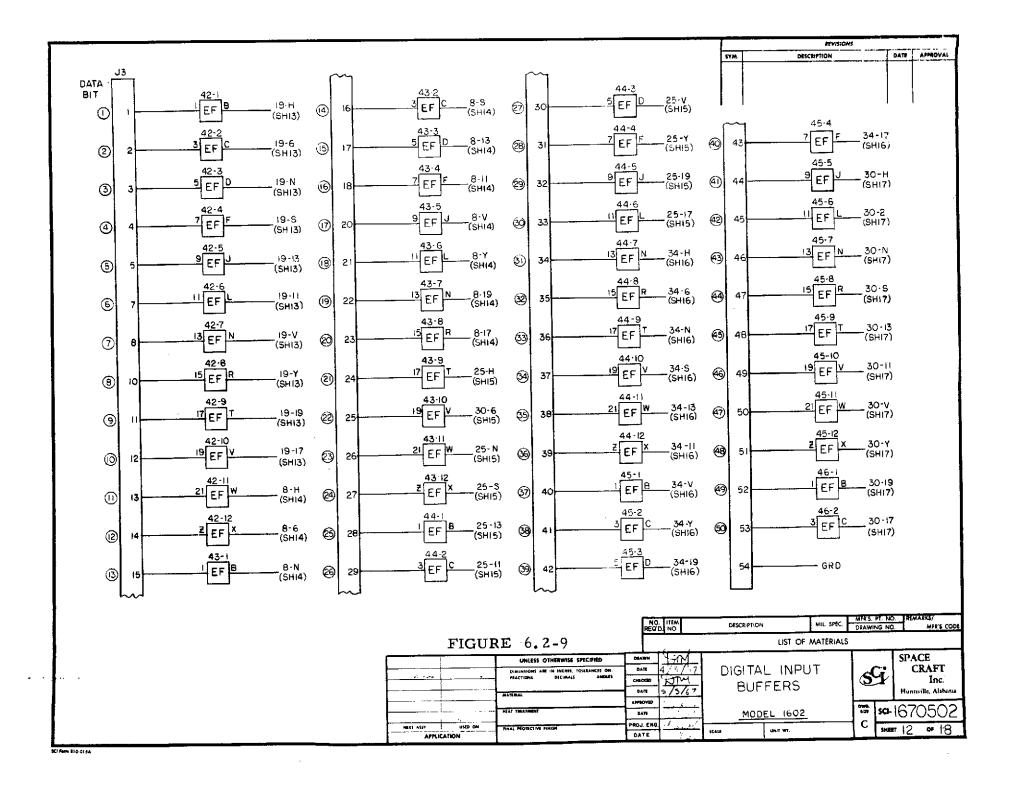


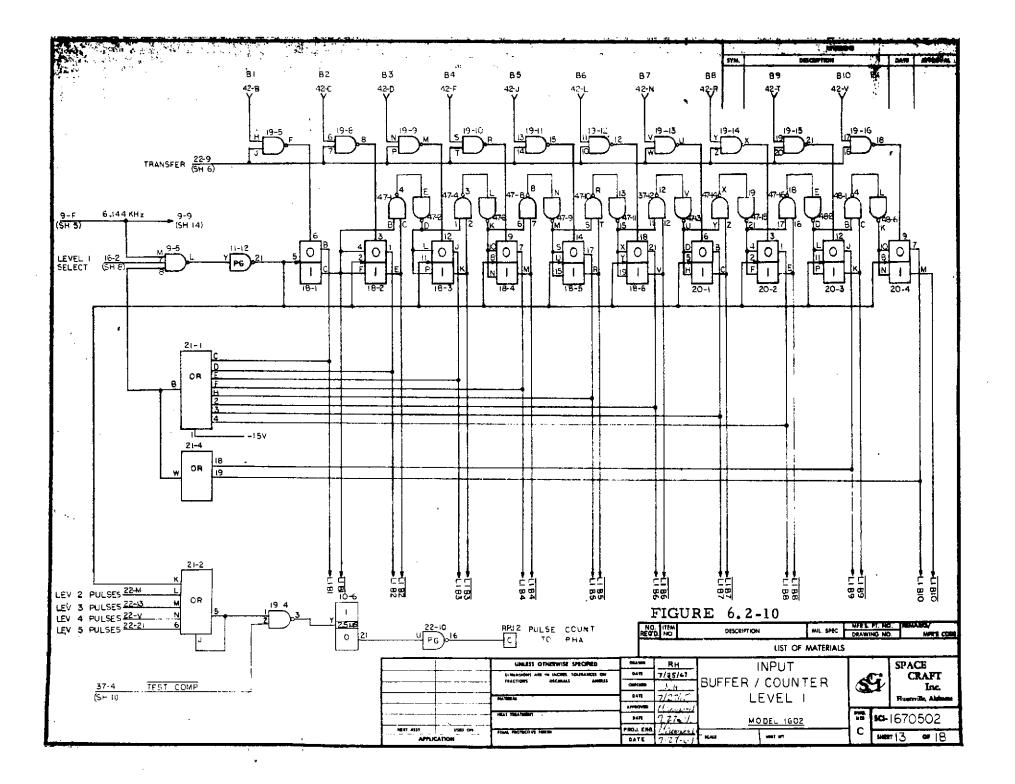


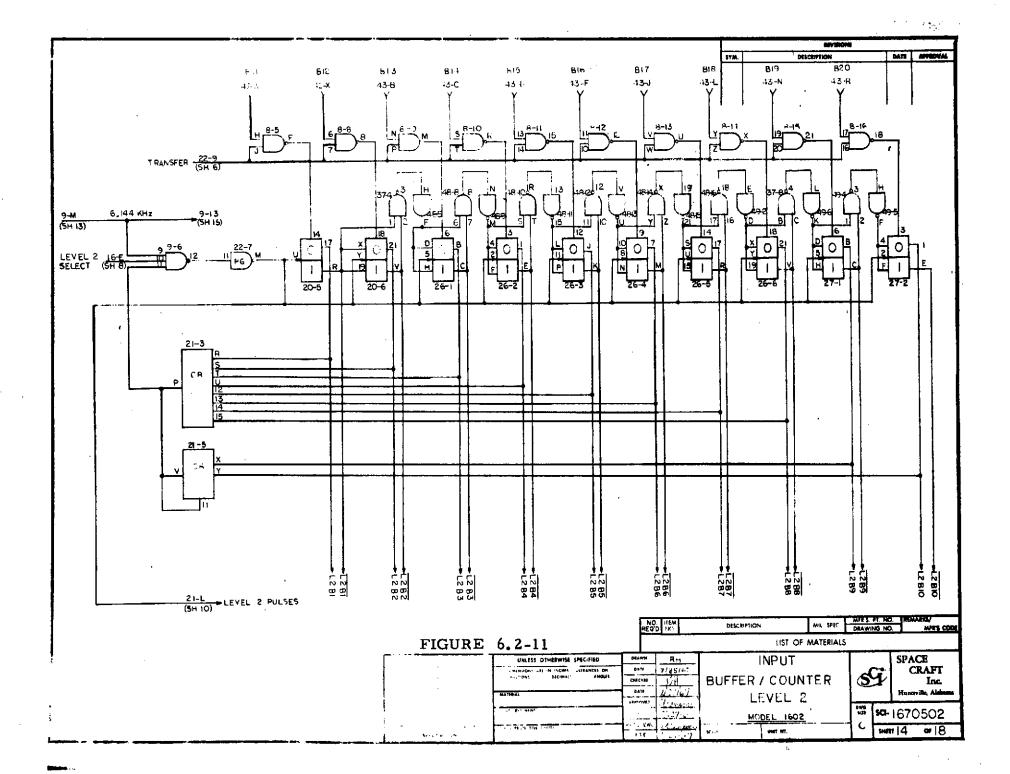


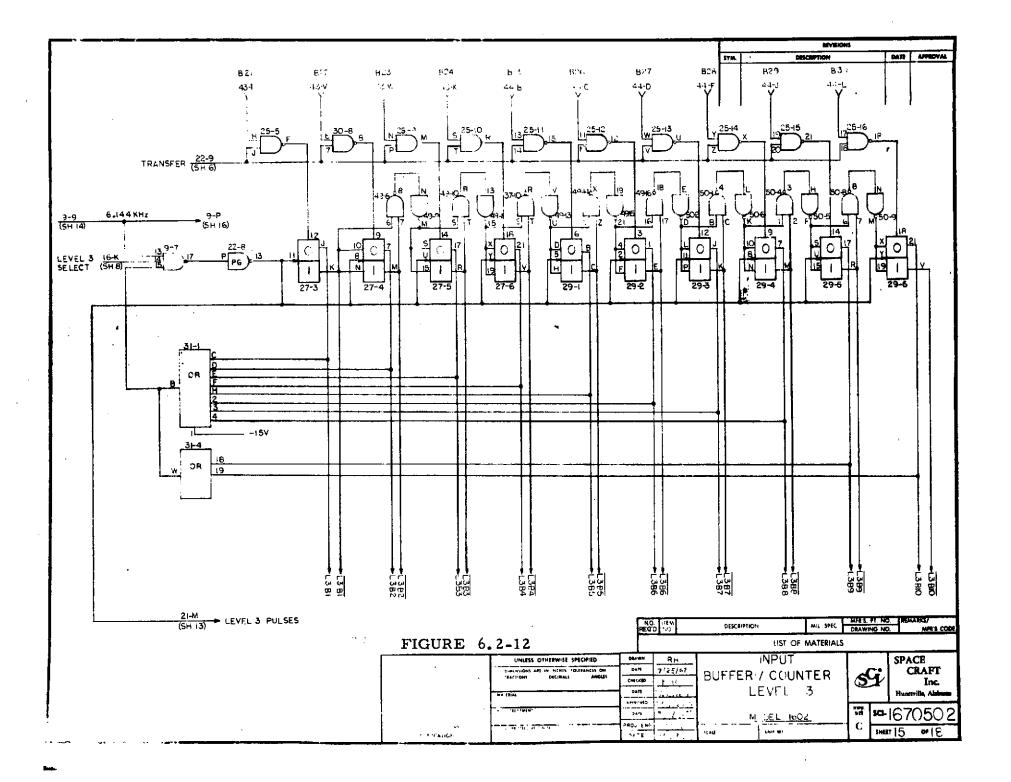


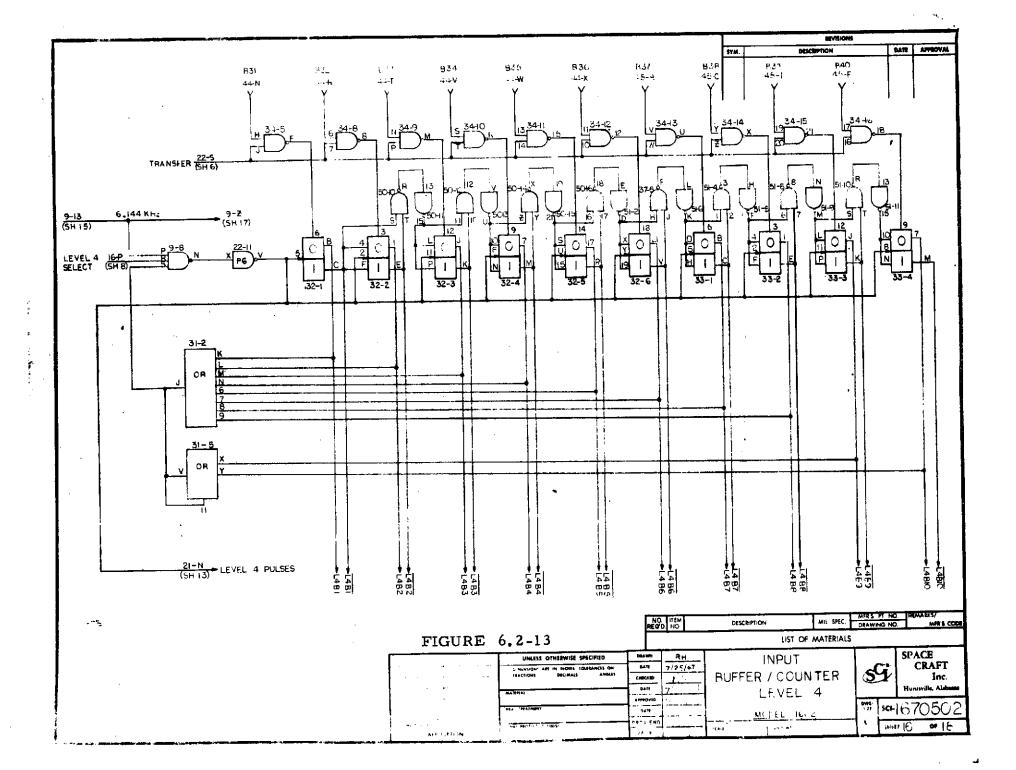


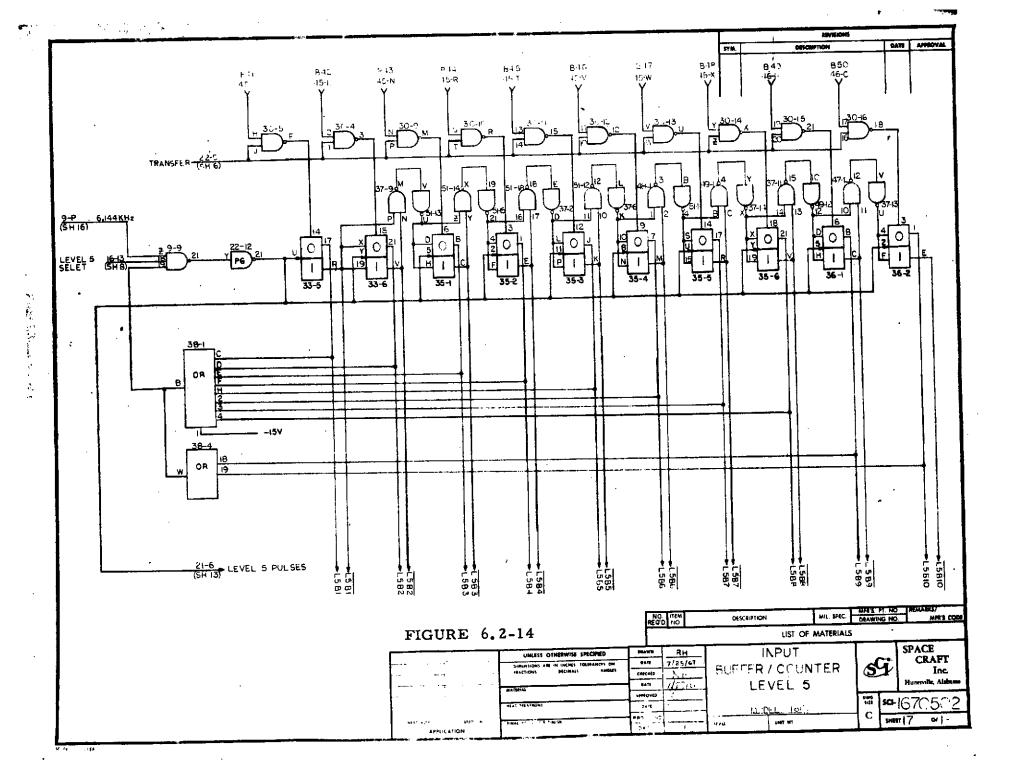


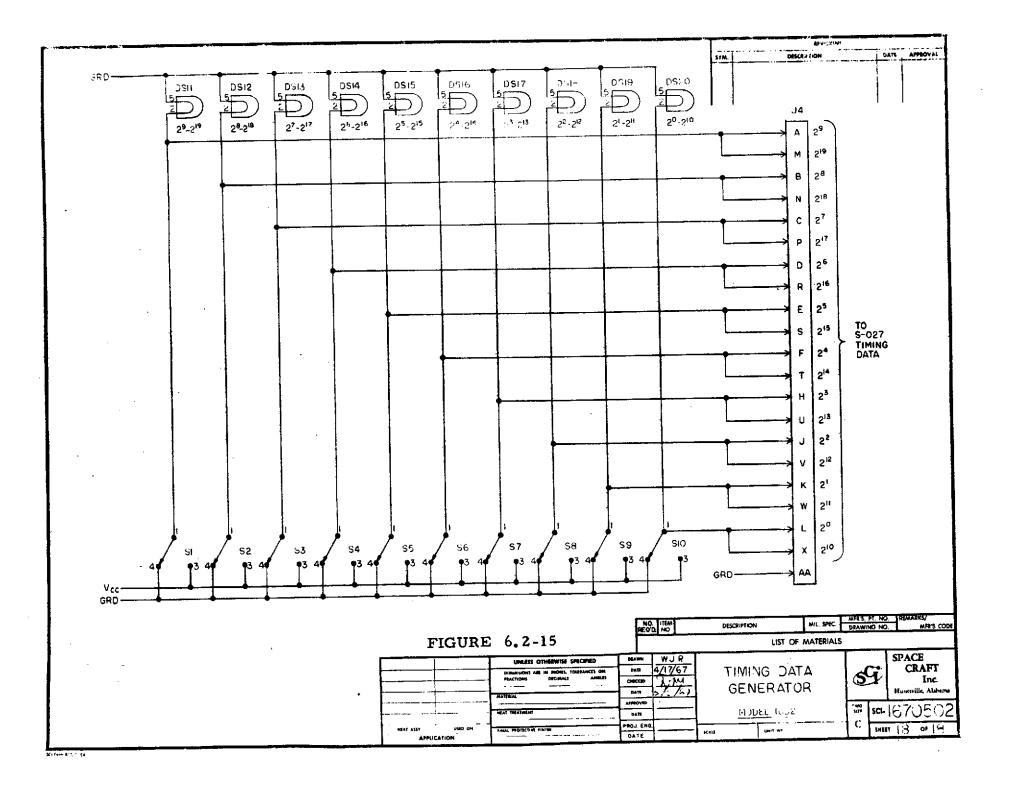












7.0 CONCLUSION

If the S-027 x-ray experiment could have been orbited as originally scheduled in 1968, the scientific information concerning x-rays which would have been obtained could have greatly increased since up until that time a majority of the information gathered was from relatively short duration flights into the upper atmosphere by sounding rockets, which were able to map only a small area of sky for limited periods. The experiment utilized many state of the art techniques in x-ray detection and signal processing.

The gas filled proportional counters involved much research since their usefulness as x-ray detectors were a function of the gas gain and high voltage. The decision concerning which gas mixture to use involved much experimentation to reach the proper trade-off point in regard to linearity and gain over the energy measurement range from 2 kev to 10 kev. The high voltage supply had to be designed with a minimum of ripple and drift in order to meet the stringent requirements to maintain an output stability of two volts variation out of a total of two thousand volts.

The pulse veto system, which detected high energy x-rays that were above the maximum energy to be analyzed by the experiment and produced data inhibit pulses corresponding to the time of the higher energy activity, was an elaborate assembly. In order to perform its function of blocking out from the total count of x-ray pulses all those above the set upper limit, the circuitry contained in the veto system had to be designed to produce a minimum delay between the detected high energy and the output veto pulse to the data processor input inhibit. This was necessary since the high energy x-rays also struck the active counters and were being analyzed and processed to the data processor thru the signal paths at the same instant the veto system was processing them, if the veto system could not produce a veto pulse at the data processor at the proper time the higher energy pulses would

be processed into the data processor as x-ray energies in the fifth level band. The system was designed with high speed switching devices to accomplish the minimum delay requirement.

At the time of the S-027 launch delay, both units were tested and ready for launch. The Qualification Unit had completed all qualification test and verified that the experiment design was such that it would both survive the launch environment and perform its objectives in orbit of mapping a large portion of the sky for x-ray activity in the 2 kev to 10 kev range.